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HELMINTHS OF *SCELOPORUS* LIZARDS IN THE GREAT BASIN AND UPPER COLORADO PLATEAU OF UTAH

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Abstract.— Fifty-five *Sceloporus* lizards representing the four species occurring in Utah were dissected. For each lizard specimen and species, helminth parasites were tabulated and classified. New host and locality records were recorded. An appendix containing literature citations of reptilian parasitology for the American Southwest is provided.

The literature dealing with the parasitic fauna of the southwestern United States contains little information on helminths of *Sceloporus* lizards. Previous studies are concerned more with a single genus or species of parasite than with the total parasitic fauna of a particular host. Even more scarce are studies of parasitic fauna from hosts in defined geographical areas.

Literature on reptilian parasites from *Sceloporus* lizards of the Great Basin and Upper Colorado Plateau of Utah is sparse and scattered. Grundmann (1957) examined 47 lizards belonging to six Utah species, one of which was *S. occidentalis;* he reported the parasites to be host specific. Grundmann (1959) later reported specific names of hosts and parasites, and locations of parasites within the host. Woodbury (1934) studied three species of Utah reptiles, including *S. graciosus.* He recovered only one species of nematode, probably because he studied only the stomach. Burkholder (personal communication) examined over 300 stomachs of *S. graciosus* and found no nematodes. He did, however, recover a cestode from the intestines of each of two lizards.

Parasites from *Sceloporus* of neighboring areas have been examined and provide useful comparisons with Great Basin and Upper Colorado Plateau populations. Waitz (1961) studied the parasites of Idaho reptiles, including *S. graciosus* and *S. occidentalis.* He recovered *Oochoristica scelopori* from the former and *Skrjabinoptera phrynosoma* from the latter. Harwood (1932) studied the helminth parasites of reptiles near Houston, Texas, and found in *S. undulatus* the nematode *Oswaldocruzia pipiens.* His paper was the first major study on reptilian parasites from a specific geographical area in the United States. Tanner and Hopkin (1972) studied the ecology of

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S. occidentalis at the Nevada Test Site and reported 41 of 145 lizards with unclassified round worms in the stomach.

Telford (1970) reported on 1485 lizards of southern California, the coastal islands, and Mexico, including *S. magister, S. graciosus,* and *S. occidentalis.* He lists many helminths, but he generally did not report the degree of infestation or the location of the parasite in the host. Stebbins and Robinson (1946) analyzed lizard populations in parts of California which included *S. graciosus.* They found three species of helminths in nine of the 15 animals examined. The parasites were classified but were described as being only from the digestive tract.

The present project was designed as a survey of helminth infestations in *Sceloporus* lizards of the Great Basin and Upper Colorado Plateau of Utah. It also contains a bibliography of literature on reptile parasitology in the southwestern United States (Appendix).

We gratefully acknowledge the help and advice of Drs. Ferron L. Andersen and Glen Moore, Departments of Zoology and Botany, respectively, Brigham Young University. Mr. Gary L. Burkholder supplied data from his study on *S. graciosus* from central Utah.

Methods and Procedures

Host lizards were noosed, removed to the laboratory, and either anesthetized with ethyl ether or pithed. They were opened from the throat to the vent and microscopically examined for parasites in the coelom, mesenteries, and intact organs. The liver, lungs, esophagus, stomach, and small and large intestines were then removed and placed in a 75 percent physiological saline solution in preparation for dissection. Approximately 25 minutes after dissection, the organs were reexamined and placed in numbered vials. The dissected lizards were hardened in 10 percent formalin and added to the herpetology museum. The method outlined by Meyer and Penner (1962) for processing helminths was followed. Worms from preserved lizards were simply removed and placed in numbered vials. Parasites were cleared in a solution of lactophenol for identification.

Literature used in the classification of helminths include Hyman (1951) and Yorke and Maplestone (1926) for the higher taxonomic categories. For the specific identification of helminths of the order Oxyuroidea, Gambino (1957a, 1957b), Lucker (1951), Read and Amrein (1953), Telford (1965), and Thapar (1925) were used. Spiruroid worms were identified by means of Babero and Kay (1967), Morgan (1942), Ortlepp (1922), and Telford (1965).

Results

Results of this study are presented in four sections, one for each species of *Sceloporus* studied. They are based on the dissection of 55 *Sceloporus*, 49 of which were anesthetized; the remaining six had previously been preserved.

Sceloporus graciosus Baird and Girard.— Literature review reveals *S. graciosus* to be parasitized by four species of helminths—

one cestode and three nematodes (Table 4). The three nematodes represent two orders: Spiruroidea (*Skrjabinoptera phrynosoma*) and Oxyuroidea (*Pharyngodon giganticus* and *Cyrtosomum penneri*).

Of 22 dissections, 11 were of males and 11 females. The only helminth recovered from the small intestine of *S. graciosus* was the tapeworm *Oochoristica scelopori.* Although this worm was as long as the entire small intestine (about 40 mm), it was contained within the duodenum of its host (about 10 mm).

All worms in the cecum were of *Cyrtosomum* and are considered pinworms of reptiles (Gambino, 1957b). *Sceloporus graciosus* is a new host for *C. readi* and *C. heynemani*, and, in addition, *C. penneri* is reported for the first time from Utah lizards. The worms were living free in the cecum of the large intestine and were in greatest numbers around and inside of fecal material on which they appeared to feed. *Cyrtosomum* species were not recovered from other regions of the intestine.

Only 60.6 percent of the total helminth population in cecums were adults. The remaining 39.4 percent were larval *Cyrtosomum* not identifiable as to species.

The *S. graciosus* specimens used in this study were from Provo Canyon and from the Little Sahara sand dunes southwest of Jericho, Utah. Of nine specimens from the Provo area, seven harbored helminths. It was in this group that *O. scelopori* was found. Six lizards harbored only *Cyrtosomum.* Four of the 13 lizards from the Jericho area were infested by *Cyrtosomum.* With the exception of *O. scelopori*, helminths of all species were recovered from lizards of these two areas. There were some differences in population composition in the worms recovered from the two areas (Table 3).

Sceloporus undulatus elongatus Stejneger.— Three species of nematodes, one from the stomach and two from the large intestine, have been reported from *S. undulatus* as summarized in Table 1. *Oswaldocruzia pipiens* belongs to the order Spiruroidea, and the two species of *Cyrtosomum* are Oxyuroidea.

The results for this species are based on the dissection of 11 adults, 8 males and 3 females. Nine of these were noosed; the other two had been preserved. Data for individual species of nematodes, with the host being considered as one unit, is recorded in Table 4; total helminth infestation per lizard is considered in Table 2.

The stomach worms, *Skrjabinoptera phrynosoma*, caused deep welts in the stomach lining by imbedding their heads, which contain a pair of internolateral teeth. This mode of attachment was so strong that the entire weight of the gastrointestinal tract could be supported by a single worm when held with forceps.

Cecal worms varied in their life styles. *Physaloptera retusa* had a similar mode of attachment to that of *Sk. phrynosoma. Pharyngodon giganticus* were free in the cecum and appeared to feed on fecal material. Although *P. retusa* and *P. giganticus* both occur in the cecum, the two did not occupy the same cecum. *Skrjabinoptera phrynosoma* occurred in one individual with *P. retusa* and in another

Table 1. Helminths harbored in four species of *Sceloporus* as reported in the literature (1-22) and this study (Utah).

	Helminth Habitat	Infested Hosts/ Total Hosts		% of Hosts Infested		Lit. Cited
		Lit.	Utah	Lit.	Utah	
Oochoristica scelopori						
S. graciosus	Sm. Int.	1/9	1/22	11	5	20
S. graciosus	Sm. Int.	7/71		10		16
S. occidentalis	Sm. Int.	27/116	1/11	23	9	16
Cyrtosomum heynemani						
S. undulatus	Cecum	2/63		3.2		2
S. graciosus	Cecum		10/22		45	
Cyrtosomum penneri						
S. graciosus	Cecum	2/20	10/22	10	45	3
S. magister	Cecum	26/52	3/11	50	27	16
S. magister	Cecum	10/1		100		3
S. occidentalis	Cecum	16/72		22		3
S. occidentalis	Cecum	7/116		6		16
Cyrtosomum readi						
S. graciosus	Cecum		10/22		45	
S. magister	Cecum/ Sm. Int.		2/11		18	
S. undulatus	Cecum	2/63		3.2		2
Pharyngodon giganticus						
S. graciosus	Cecum	22/71		34		16
S. occidentalis	Cecum	24/116	3/11	21	27	16
S. undulatus	Cecum		2/11		18	
Physaloptera retusa						
S. magister	Cecum		1/11		9	
S. occidentalis	Stomach	7/7	5/11	100	45	5
S. occidentalis	Stomach	15/116		13		16
S. undulatus	Cecum		1/11		9	
Oswaldocruzia pipiens						
S. undulatus	Stomach	1/3		33		6
Skrjabinoptera phrynosoma						
S. graciosus	Stomach	9/15		60		14
S. magister	Stomach		3/11		27	
S. occidentalis	Stomach	1/5		20		20
S. undulatus	Stomach		7/11		63	
Thelandros iguanae						
S. occidentalis	Cecum	1/116		.9		15, 16
Thubunaea iguanae						
S. magister	Stomach	12/52	2/11	23	19	15

host with *P. giganticus*. These were the only cases of multispecies infestations in *S. undulatus*.

All three lizards from the Zion National Park area harbored helminths. One of these contained both the stomach worm *Sk. phrynosoma* and the cecal worm *P. giganticus*. All lizards from Arches National Park carried *Sk. phrynosoma*, and one a female *P. retusa* in the cecum. None of the lizards from the St. George-Santa Clara area had helminths. The one from Price, Utah, harbored *S. phrynosoma* (Table 3).

Sceloporus occidentalis biseriatus Hallowell.— Literature reveals *S. occidentalis* to harbor six species of helminths (Table 4). *Oochoristica scelopori* was the only cestode recovered. The nematodes were *Skrjabinoptera phrynosoma* and *Physaloptera retusa*, order Spiruroidea; and *Cyrtosomum penneri*, *Pharyngodon giganticus*, and *Thelandros iguanae*, order Oxyuroidea.

Seven anesthetized and four preserved specimens were dissected. Three species of helminths were recovered: *O. scelopori*, *P. retusa*, and *P. giganticus*. Nine larval nematodes (*Skrjabinoptera* or *Physaloptera*) were recovered from a single cecum. Table 1 provides data for the individual species of nematodes, whereas the total helminths per infested host is given in Table 2.

The stomach worm *Physaloptera retusa* was always found in the anterior third of the stomach. The mode of attachment was similar to that previously noted for *Sk. phrynosoma* in *Sceloporus undulatus*. There was, however, a major structural difference in that *P. retusa* had the cuticle reflected over the lips, and the teeth were dissimilar

TABLE 2. Total helminths per lizard and infestations of host organs expressed in maximum, minimum, and average for the four species of *Sceloporus* occurring in Utah.

	Maximum	Minimum	Average Per Infested Host
Helminths Per Lizard			
S. graciosus	250	1	140
S. magister	240	2	102
S. occidentalis	14	1	7
S. undulatus	12	1	5.7
Helminths Per Organ			
Cecum			
S. graciosus	250	10	154
S. occidentalis	8	1	4
S. undulatus	10	1	5
Duodenum			
S. graciosus	1	1	1
S. occidentalis	1	1	1
S. undulatus	8	1	4.4
Large Intestine			
S. magister	200	150	150
Small Intestine			
S. magister	100	10	55
Stomach			
S. magister	30	2	10.4
S. occidentalis	13	1	5

TABLE 3. Differences in parasites between different populations of Utah *Sceloporus*.

	Arches	Dividend	Dugway Mtns.	NW of Elberta	Price	Provo Canyon	Little Sahara	St. George	Zion
Cyrtosomum heynemani									
S. graciosus						6/9	4/13		
Cyrtosomum penneri									
S. graciosus						6/9	4/13		
S. magister	2/3				1/3			0/5	
Cyrtosomum readi									
S. graciosus						6/9	4/13		
S. magister	2/3				0/3			0/5	
Oochoristica scelopori									
S. graciosus						1/9	0/13		
S. occidentalis				1/4					
Pharyngodon giganticus									
S. occidentalis		1/4	1/2	1/4				1/1	
S. undulatus	0/4				0/1			0/3	2/3
Physaloptera retusa									
S. magister	1/3				0/3			1/5	
S. occidentalis		2/4	1/2	1/4				1/1	
S. undulatus	1/4				0/1			0/3	0/3
Skrjabinoptera phrynosoma									
S. magister	2/3				0/3			1/5	
S. undulatus	4/4				1/1			0/3	2/3
Thubunaea iguanae									
S. magister	1/3				1/3			0/5	

in number and structure (Ortlepp, 1922). As described for *Sk. phrynosoma*, attachment was secure and caused welts in the stomach lining. When the stomachs were empty, the bodies of the worms laid straight and usually passed anteriorly into the esophagus. When food was present, their bodies were coiled in the anterior of the stomach.

The tapeworm *Oochoristica scelopori* inhabited the duodenum of the small intestine. This is the first report of *O. scelopori* in *S. occidentalis* of Utah; it was previously reported from California (Telford, 1970).

Pharyngodon giganticus were only found to inhabit the cecal portion of the large intestine and to move freely in the fecal material. This is the first time *P. giganticus* has been reported in *S. occidentalis* of Utah. It was previously found in *S. occidentalis* of California (Telford, 1970).

The cecum of one preserved lizard contained the eight larval nematodes previously mentioned. They were not attached to the intestinal wall when recovered, and no welts were seen on the cecal lining. Anatomical characters are not sufficiently known to identify them.

Host lizards were captured at four localities. Four came from an area northeast of Dividend, Utah. Two of these were parasitized by *P. retusa*, and one by *P. giganticus*. Two came from the Dugway Mountains; one of these harbored *P. retusa* in the stomach and *P. giganticus* in the cecum. Northwest of Elberta, Utah, four lizards were collected, two of which harbored worms. One had the tapeworm *O. scelopori* in the duodenum, and the other contained *P. retusa* in the stomach and *P. giganticus* in the cecum. One lizard

TABLE 4. Record of helminths which have infested *Sceloporus* hosts.

Host Lizard	Reported in this Study	Reported from other Studies
S. graciosus	*Oochoristica scelopori* *Cyrtosomum penneri* *Cyrtosomum readi** *Cyrtosomum heynemani**	*Oochoristica scelopori* *Cyrtosomum penneri* *Skrjabinoptera phrynosoma* *Pharyngodon giganticus*
S. undulatus	*Skrjabinoptera phrynosoma** *Physaloptera retusa** *Pharyngodon giganticus**	*Oswaldocruzia pipiens* *Crytosomum heynemani* *Cyrtosomum readi*
S. occidentalis	*Oochoristica scelopori* *Physaloptera retusa* *Pharyngodon giganticus* Spiruroidea larva	*Oochoristica scelopori* *Physaloptera retusa* *Pharyngodon giganticus* *Skrjabinoptera phrynosoma* *Cyrtosomum penneri* *Thelandros iguanae*
S. magister	*Thubunaea iguanae* *Cyrtosomum penneri* *Cyrtosomum readi** *Physaloptera retusa** *Skrjabinoptera phrynosoma**	*Thubunaea iguanae* *Cyrtosomum penneri*

*Indicates new host record.

was from the St. George-Santa Clara area; it had 13 *P. retusa* in the stomach and one *P. giganticus* in the cecum.

Sceloporus magister Hallowell.— Literature on *S. magister* (Table 4) reports two species of nematodes: *Thubunaea iguanae*, a spiruroid, and *Cyrtosomum penneri*, an oxyuroid.

The nematodes *S. phrynosoma*, *P. retusa*, and *C. readi* are added to the host lists given by Gambino (1957b) and Telford (1965, 1970). *Thubunaea iguanae* and *C. penneri* are also reported for the first time to infest *S. magister* from Utah (Table 4). Both nematodes were reported in *S. magister* from California (Telford, 1965). Our data were obtained from 11 specimens (three male and eight female) of *S. magister*.

Forty-five percent of the hosts were parasitized by *Sk. phrynosoma* and *T. iguanae;* however, they were not found together in the same host. Both were similarly attached to the stomach lining but differed in their cutical structures, oral papillae, teeth, and reproductive organs (Babero and Kay, 1967; Telford, 1970). *Thubunaea iguanae* was not as deeply imbedded in the stomach lining as was *Sk. phrynosoma*, although both worms were attached in the anterior half of the stomach in all but one of the lizards. In the one exception, a preserved specimen, *Sk. phrynosoma* was free in the stomach.

Two hosts were infested by *Cyrtosomum* (Table 3). Two preserved lizards had these worms in the small intestine and cecum. We have observed these parisites migrating when hosts were being preserved; this may account for their presence in the small intestine. An anesthetized specimen had approximately 150 *Cyrtosomum* free in the cecum and one female *P. retusa* attached to the lining.

We examined 11 lizards; of the five from the St. George-Santa Clara area, one contained *S. phrynosoma*. Of the three from Arches National Park, all contained helminths in the stomach, two had worms in the cecum, and one had worms in both the small intestine and the cecum. The three remaining lizards came from eastern Utah near Price. Two of these harbored helminths, one containing six stomach worms, *T. iguanae*, and the other containing approximately 100 *Cyrtosomum* in the small intestine and 100 in the cecum.

Helminths recovered from their respective hosts as reported in this study are compared to those reported in the literature in Table 4. A summary of host relationships for the helminths recovered by us, with results of past studies, are recorded in Table 1.

Discussion

The prime objective of this study was the identification of helminths in *Sceloporus* lizards of the Great Basin and Upper Colorado Plateau of Utah. Fifty-five lizards representing four species of *Sceloporus* were dissected and eight helminth species recovered. The following is a discussion of each helminth species.

Oochoristica scelopori.— This is a tapeworm of reptiles. Two specimens were recovered, one from the duodenum of *S. graciosus*

and one from the duodenum of *S. occidentalis*. Both hosts were adult females.

This cestode has been reported from *S. graciosus* and *S. occidentalis* in southern California (Telford, 1970) and *S. graciosus* in Idaho (Waitz, 1961). A single cestode was found in one of the nine *S. graciosus* from Provo Canyon. Burkholder (personal communication) autopsied more than 300 Utah specimens of *S. graciosus* and found one cestode each in two lizards also from Provo Canyon. The probable explanation of this apparent nidus, or nested distribution, lies with the unknown intermediate host. The intermediate host presumably is an arthropod having a narrower environmental tolerance than *S. graciosus*. This possibility is strengthened by the absence of this parasite in 13 lizards from the Little Sahara sand dunes southwest of Jericho, Utah.

Telford (1970) attempted to measure the effect of altitude on frequencies of parasitic infestations. He reported that the occurrence of cestodes in lizards was due to the sympatric occurrence of intermediate and definitive hosts and that the presence of intermediate hosts was dependent on the altitude. Telford's measurement of altitude was actually the sum total of climatic factors. The infested specimens of *S. graciosus* from Provo Canyon are from an area where water and vegetation are relatively abundant compared to dryer areas west of the Wasatch Front such as the Little Sahara sand dunes. Therefore, the unknown intermediate host is probably an arthropod inhabiting cooler, moister habitats.

The habitat of *O. scelopori* is seemingly the duodenum of the small intestine. Since this is the main organ of digestion (Villee and Dether, 1971), this parasite has an advantage in securing nutrients formed by the digestive processes of the host.

The effects of *O. scelopori* on the hosts were apparently negligible. Neither *S. graciosus* nor *S. occidentalis* appeared to have structural damage. Although there may have been some competition between hosts and parasites for the nutrients, the hosts were adults with fat bodies in the coelum, indicating an excess of nutrients. It is, of course, possible that multiple infestations of this worm would damage the host.

In both host lizards there were no other helminths harbored. The possibility exists that *O. scelopori* has some mechanism which limits or interferes with other helminths. The literature is inconclusive on this point, and laboratory experimentation would be necessary to establish this hypothesis.

A wide distribution is shown by *O. scelopori*. Telford (1970) reports this cestode in lizards of Iguanidae and Xantusiidae, for which families it is seemingly host specific.

Skrjabinoptera phrynosoma.— This species is the best known stomach worm of reptiles in the southwestern United States. We have recovered 47 specimens from two species of *Sceloporus*. Seven of 11 specimens of *S. undulatus* and three of 11 specimens of *S. magister* harbored this worm. This appears to be the first report of this parasite in these species.

A possible nidus distribution exists for *Sk. phrynosoma* within the Great Basin and the Upper Colorado Plateau of Utah. Six of seven lizards, representing both host species, from Arches National Park were parasitized. In the St. George-Santa Clara area, however, only one of eight hosts harbored the worm.

In infested stomachs of anesthetized lizards, *Sk. phrynosoma* was always located in the first third of the stomach with the head deeply buried in the stomach lining. The reason for this anterior attachment is not known. There may be less movement of the stomach anteriorly, or it may allow the parasite to extend without moving into the environment of the small intestine where the pH is quite different.

Externally, lizards with *Sk. phrynosoma* could not be distinguished from those without. Internally, however, the worms caused great welts in the stomach lining. There were no signs of tissue inflammation or disintegration, but infestation was light. In some horned lizards, reported infestations are as high as 500 worms, with an average of 50 worms per lizard, and tissue damage is severe (Babero and Kay, 1967). However, the maximum number of worms in *S. magister* was 10, and in *S. undulatus* eight; the average for both species was about five worms per host. It seems that *Sk. phrynosoma* is not as abundant in *Sceloporus* as it is in *Phrynosoma platyrhinos*. The latter is a notorious ant eater, and since ants are intermediate hosts (Lee, 1957), we suspect that one or more species of ants may be involved in the parasitic cycle.

Skrjabinoptera phrynosoma is limited to the family Iguanidae but is widely scattered through many of its genera (Telford, 1970). Physiological host specificity exists at the intermediate host level (Lee, 1957), but apparent preference for certain definitive hosts is ecologically determined by the dietary specializations of the host (Telford, 1970).

Physaloptera retusa.— This species was recovered from *S. occidentalis*, *S. undulatus*, and *S. magister*, the latter two constituting new host records. *Physaloptera retusa* is typically a stomach worm of *S. occidentalis* (Telford, 1970), but in both of the new hosts *P. retusa* was recovered from the cecum.

In this study, specimens of *S. occidentalis* were captured from the foothills west of Utah Lake and *S. undulatus* and *S. magister* were taken from Arches National Park.

Sceloporus occidentalis was first reported to harbor *P. retusa* by Grundmann (1959), who examined seven specimens from Utah. Since then, Telford (1970) has reported this nematode to be the most common stomach worm parasitizing *S. occidentalis* in southern California. Perhaps it is now justifiable to say that *P. retusa* is the most abundant stomach worm of *S. occidentalis* in the southwestern states. *Sceloporus magister* and *S. undulatus* harbored five and ten specimens respectively of the stomach worm *Skrjabinoptera phrynosoma*. It is interesting to note that *P. retusa* occurs in the cecum of these species and in the stomach of *S. occidentalis*.

The effects of *P. retusa* on its *Sceloporus* hosts appeared negligible. Attachment of worms to host stomachs was similar to that described for *Sk. phrynosoma.* Grundmann (1959) thought *P. retusa* was host specific for *S. occidentalis,* but Telford (1970) has shown it to be in genera as diverse as *Crotaphytus, Uta, Callisaurus, Eumeces,* and *Gerrhonotus.* He suggested that host specificity of *P. retusa* is dependent on ecological factors similar to those in *Sk. phrynosoma,* the main factor being the diet of host lizards, which explains the distribution of this parasitic worm. Telford attributed the lack of *P. retusa* in *S. magister* from southern California to the absence in their diet of an unknown intermediate host. The presence of *P. retusa* in both *S. magister* and *S. undulatus* from Arches National Park indicates that the intermediate host is a common item in these diets.

Thubunaea iguanae.— This spiruroid nematode was found in the stomachs of two specimens of *S. magister.* One, from Arches National Park, had 30 worms; the other, from the Price area, had six. This is a sizable range extension for this nematode. Telford (1970) originally reported its occurrence in *S. magister.*

The effects of *T. iguanae* on its host appeared negligible. The head of the worm was imbedded, but the attachment did not appear as strong as that reported above for *Sk. phrynosoma* and *P. retusa.* Both hosts were adults, apparently in good health. The effects of *T. iguanae* on other species of helminths could not be determined; however, there is a possibility that *Sk. phrynosoma* may have affected the distribution of *T. iguanae.* These helminths were not recovered from the same host. As noted above, *P. retusa* was not recovered from stomachs containing *Sk. phrynosoma.* These two facts support a theory that *Sk. phrynosoma* affects the presence and/or distribution of other nematodes within the host.

This nematode is harbored by several species from each of the following families of reptiles: Iguanidae, Xantusiidae, Teiidae, and Gekkonidae (Telford, 1970).

Pharyngodon giganticus.— This nematode belongs to the order Oxyuroidea, and was found in the cecum. It was recovered from two specimens of *S. undulatus* from Zion National Park, as well as from four specimens of *S. occidentalis*—three from west of Utah Lake and one from St. George, Utah. *Sceloporus undulatus* represents a new host record for *P. giganticus.*

The effects of *P. giganticus* upon hosts were apparently negligible. This helminth lives in the fecal material of the host's cecum. The host-worm relationship appears to be commensal. There is the possibility that under heavy infestations this worm may be injurious to the host; however, such was not noted by us.

The effect of *P. giganticus* on other oxyuroid helminths is a possibility, since there were no other oxyuroid worms sharing the cecum with it; however, there were no other oxyuroid species found in specimens of *S. undulatus* or *S. occidentalis.*

Oxyuroid nematodes show a greater degree of host specificity than do the spiruroids previously mentioned. Telford (1970) reports *P. giganticus* to be restricted to *Sceloporus*, with the exception of two widely separated island populations of *Uta*, which he suggests may be a relict distribution.

Cyrtosomum penneri, *C. heynemani*, and *C. readi*.— These three oxyuroids are considered together because of the many similarities in host, habitat, and life style. The *Cyrtosomum* species were usually found in association with either one or both of the other *Cyrtosomum* species. All three species were recovered from specimens of *Sceloporus graciosus* taken from Provo Canyon and the Little Sahara sand dunes. *Cyrtosomum penneri* and *C. readi* were recovered from one specimen of *S. magister* taken from Arches National Park and also from one specimen from the Price area. This study reports *S. graciosus* as a new host for *C. readi*. Gambino (1957a, 1957b) describes and discusses the morphology of these nematodes.

All three *Crytosomum* nematodes infested the ceca of their hosts. In only two specimens of *S. magister* did these worms occur outside of the cecum; since both lizards were preserved specimens, this occurrence could be explained by a migration at the time of preservation. Dissections and observations of infested hosts revealed that *Cyrtosomum* worms probably live exclusively in the cecum. Ecological barriers such as peristaltic movement, scarcity of food, and restriction in space may be limiting factors. Physiological barriers in the large intestine may limit worm distribution past the cecum, where the colon removes most of the water and concentrates metabolic wastes. These would cause osmotic and pH gradients that might impair the survival of parasites.

The effects on the host by *Cyrtosomum* nematodes appeared negligible. At times, 300 worms occurred in a single host. Such heavy infestations of *Cyrtosomum* worms often caused the walls of the cecum to move as the worms pushed against it. This may have caused irritation; however, there was no tissue damage noted. Worms were seemingly feeding on the fecal matter, and thus were not competing with the host for food but living in a commensal relationship.

The presence or absence of other nematodes showed no effect on the presence or abundance of *Cyrtosomum* worms. *Cyrtosomum penneri* was the most commonly occurring *Cyrtosomum*. It shared all the infested lizards harboring either *C. readi* or *C. heynemani* and was found in two *S. magister* lizards by itself. *Cyrtosomum heynemani* was the only species which did not occur in *S. magister*. This may not be significant, because some experts are not certain that *C. readi* is a distinct species from *C. heynemani* (Babero and Kay, 1967).

Cyrtosomum are host specific to the family Iguanidae, infesting many genera including *Dipsosaurus*, *Crotaphytus*, *Sauromalus*, *Phrynosoma*, *Uta*, *Callisaurus*, and *Sceloporus* (Telford, 1970).

Conclusions and Summary

Dissections of 55 lizards representing four species of *Sceloporus* resulted in the recovery of eight species of helminths. These include: a cestode, *Oochoristica scelopori;* three species of spiruroid nematodes, *Skrjabinoptera phrynosoma*, *Physaloptera retusa*, and *Thubunaea iguanae;* and four species of oxyuroid nematodes, *Pharyngodon giganticus*, *Cyrtosomum penneri*, *C. heynemani*, and *C. readi*. Eight new host records were reported, and the geographic distribution was extended for most of the parasitic species.

Host specificity was not restrictive enough to indicate phylogenetic relations between host species. The occurrence of helminths in *Sceloporus* lizards apparently was correlated with the distribution of intermediate hosts and the diets of definitive hosts. The effects of helminths on their *Sceloporus* hosts were apparently slight; however, infestations of cestodes or spiruroid nematodes was light. The possibility exists that lizards with high infestations have a lower survival rate. Oxyuroid nematodes did occur in great numbers, but in all cases the hosts appeared healthy.

The effects of helminths on other helminths in the same host were indicated. Stomachs were parasitized by a single species of nematode even when other helminths, usually inhabitants of the stomach, were recovered from the same lizard. *Skrjabinoptera phrynosoma* was apparently dominant to both *Physaloptera retusa* and *Thubunaea iguanae*.

There were some differences in number and types of parasites found in the same host from different collecting sites. Specimens from the St. George-Santa Clara area were almost free of helminths, whereas those from Arches National Park were all infested. This nested distribution evidently resulted from different diets and the presence or absence of intermediate hosts in the locality.

Appendix

The literature available on reptilian parasitology from the American Southwest is presented as an addition to this study. We recognize the bibliographic contributions of Dr. Sophie Jakowska.

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MISCELLANEOUS CHROMOSOME COUNTS OF WESTERN AMERICAN PLANTS—II[1]

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Abstract.— Chromosome numbers are reported for 19 species of western American plants. Reports for previously uncounted species include *Nitrophila mohavensis* Munz and Roos, $n=18$; *Eriogonum contiguum* (Reveal) Reveal, $n=16$; *Mentzelia leucophylla* Brandeg., $n=18$, and *M. torreyi* A. Gray, $n=12$; *Prunus virginiana* L. var. *melanocarpa* (A. Nels.) Sarg., $n=8$; *Astragalus beatleyae* Barneby, $n=11$; *Angelica kingii* (S. Wats.) Coult. and Rose, $n=22$; *Gilia nyensis* Reveal, $n=9$; and *Arnica parryi* A. Gray var. *sonnei* (Greene) Cronq. in Ferris $n=19$. New ploidy levels are reported in *Oxystylis lutea* Torr. and Frém., $n=10$; *Lupinus aridus* Dougl. ex Lindl., $n=12$; and *Castilleja martinii* Abrams var. *clokeyi* (Pennell) N. H. Holmgren, $n=12$. Seven additional counts are given which confirm those published by others. These are *Opuntia chlorotica* Engelm. and Bigel., $n=11$; *Eriogonum inflatum* Torr. and Frém. var. *inflatum*, $n=16$, *E. trichopes* Torr., $n=16$, and *E. bifurcatum* Reveal, $n=20$; *Stanleya pinnata* (Pursh) Britt. var. *inyoensis* (Munz and Roos) Reveal, $n=28$; *Lupinus argenteus* Pursh, $n=24$; and *Castilleja viscidula* A. Gray, $n=12$.

In this series of papers, of which this is the second, chromosome counts of randomly gathered western American plants will be reported as part of the Intermountain Flora Project (headed by Arthur Cronquist of the New York Botanical Garden and aided by Arthur H. Holmgren, Noel H. Holmgren, and James L. Reveal) and the proposed Southwest Flora Project (headed by Noel H. Holmgren and James L. Reveal). These counts will be presented from time to time by Reveal and various others of his colleagues or students and will be based on materials gathered by him or others. The present paper reports on some of the miscellaneous plants gathered in southern Nevada in 1970 and 1971.

Flower buds were collected in developmental series from plants growing in their native habitats. The buds were fixed in ethanol and glacial acetic acid (3:1) and refrigerated; the buds were not transferred to 70 percent ethanol after 24 hours, as is the usual technique. Anthers were squashed in acetocarmine and illustrations drawn using a camera lucida mounted on a Wild M20 research microscope. Most of the counts reported here were made by Reveal. Voucher specimens are deposited in the herbarium at the Nevada Test Site, with duplicates deposited in several major herbaria.

Chromosome numbers of 19 species of western American plants are reported here, nine for the first time, with three counts of new ploidy levels. One count is given for a species already reported in the literature but not figured, and six counts confirm those made previously by others.

Opuntia chlorotica Engelm. and Bigel. $n=11$. Figs. 1, 2. This count confirms those made by others (Stockwell, 1935; Pinkava and

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McLeod, 1971). The voucher is *Beatley and Reveal 11231*, west side of Spring Mountains [Charleston Mountains], Clark Co., Nevada, 17 June 1970.

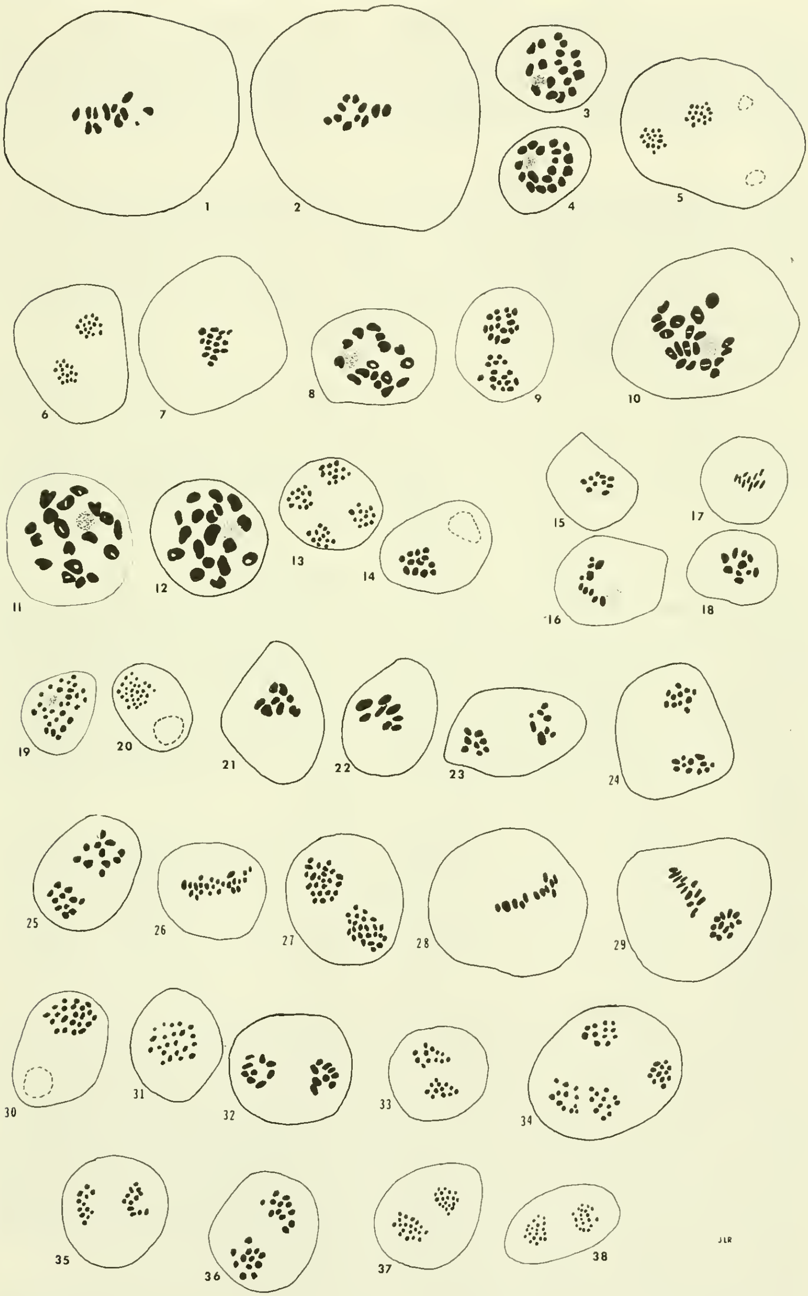
Nitrophila mohavensis Munz and Roos. $n=18$. Figs. 3, 4. This rare species is known only from a small site in extreme eastern Inyo Co., California, where it is a locally dominant species. It would appear that *N. mohavensis* is a tetraploid, since Covas and Schnack (1947) have reported a count of $n=9$ for the South American species *N. australis* Chod. and Wilc., although a second North American species, *N. occidentalis* (Nutt.) Moq., should be counted to confirm this. Nevertheless, it seems possible to state that the base number for *Nitrophila* is $x=9$. The voucher collection is *Reveal 2291*, Amargosa Desert, southern Ash Meadows, along the road between Ash Meadows and Death Valley Junction on the saline flats of Carson Slough, Inyo Co., California, 5 May 1971.

Eriogonum inflatum Torr. and Frém. var. *inflatum*. $n=16$. Fig. 5. This count confirms those made by Stone and Raven (1958) and Reveal (1965). The voucher is *Reveal 2290*, Stewart Valley, 2 miles north of Nevada Highway 52 on road to Ash Meadows, Nye Co., Nevada, 5 May 1971.

Eriogonum contiguum (Reveal) Reveal. $n=16$. Figs. 6, 7. When this plant was counted and found to equal that of *E. inflatum* and *E. trichopes*, and when fieldwork showed no hybridization between the three, it was decided to elevate *E. inflatum* var. *contiguum* to the species rank (Reveal, 1972). The voucher of this new count is *Reveal 2288*, Stewart Valley, 2 miles north of Nevada Highway 52 on road to Ash Meadows, Nye Co., Nevada, 5 May 1971.

Eriogonum trichopes Torr. $n=16$. Figs. 8, 9. This count confirms that made previously (Reveal, 1965). The voucher is *Reveal 2289*, Stewart Valley, 2 miles north of Nevada Highway 52 on road to Ash Meadows, Nye Co., Nevada, 5 May 1971.

Figs. 1, 2: *Opuntia chlorotica*, $n=11$—metaphase I. Figs. 3, 4: *Nitrophilia mohavensis*, $n=18$—diakinesis. Fig. 5: *Eriogonum inflatum* var. *inflatum*, $n=16$—telophase II. Figs. 6, 7: *Eriogonum contiguum*, $n=16$—anaphase I, Fig. 6; metaphase I, Fig. 7. Figs. 8, 9: *Eriogonum trichopes*, $n=16$—diakinesis, Fig. 8; anaphase I, Fig. 9. Fig. 10: *Eriogonum bifurcatum*, $n=20$—diakinesis. Figs. 11, 12: *Mentzelia leucophylla*, $n=18$—diakinesis. Figs. 13, 14: *Mentzelia torreyi*, $n=12$—telophase II, Fig. 13; anaphase II, Fig. 14. Figs. 15, 16, 17, 18: *Oxystylis lutea*, $n=10$—metaphase I, Figs. 15, 17, 18; diakinesis, Fig. 16. Figs. 19, 20: *Stanleya pinnata* var. *inyoensis*, $n=28$—diakinesis, Fig. 19; anaphase I, Fig. 20. Figs. 21, 22, 23: *Prunus virginiana* var. *melanocarpa*, $n=8$—metaphase I, Figs. 21, 22; anaphase I, Fig. 23. Figs. 24, 25: *Astragalus beatleyae*, $n=11$—anaphase I. Figs. 26, 27: *Lupinus argenteus*, $n=24$—metaphase I, Fig. 26; anaphase I, Fig. 27. Figs. 28, 29: *Lupinus aridus*, $n=12$—metaphase I, Fig. 28; metaphase II, Fig. 29. Figs. 30, 31: *Angelica kingii*, $n=22$—anaphase I, Fig. 30; metaphase I, Fig. 31. Fig. 32: *Gilia nyensis*, $n=9$—anaphase I. Figs. 33, 34: *Castilleja viscidula*, $n=12$—anaphase I, Fig. 33; telophase II, Fig. 34. Figs. 35, 36: *Castilleja martinii* var. *clokeyi*, $n=12$—anaphase I. Figs. 37, 38: *Arnica parryi* var. *sonnei*, $n=19$—anaphase I.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Eriogonum bifurcatum Reveal. $n=20$. Fig. 10. When this species was proposed (Reveal, 1971), the chromosome number was noted but a figure not provided. The voucher of this count is *Reveal 2283*, Pahrump Valley, 1 mile east of the California-Nevada state line just south of Nevada Highway 52, Nye Co., Nevada, 13 June 1970.

Mentzelia leucophylla Brandeg. $n=18$. Figs. 11, 12. As currently understood, this is a rather rare species of eastern California and adjacent southern Nevada. The count indicates the species to be a polyploid (most likely a tetraploid), but one would like more counts of the species from throughout its range to confirm this point. The voucher is from the type location in Ash Meadows, Nye Co., Nevada, based on *Reveal 2247*, 11 June 1970.

Mentzelia torreyi A. Gray. $n=12$. Figs. 13, 14. This count is most unusual, since this number is unknown (at least to us) for the genus. A more reasonable number would be $n=11$, but our report was confirmed by a number of smears. Bud material was obtained by Reveal and Beatley on 14 June 1970 from the same place Reveal made a collection earlier. The voucher is *Reveal 1980*, Kawich Valley, Nye Co., Nevada, 31 August 1968.

Oxystylis lutea Torr. and Frém. $n=10$. Figs. 15, 16, 17, 18. Raven, Kyhos, and Hill (1965) recently reported the number of $2n=20$ pairs for this species, but our counts would indicate their plants to have been tetraploids, since our count is just half theirs. Based on these data, the base number for the genus would be $x=10$. Our voucher is *Reveal 2248*, west of Ash Meadows, along a dirt road southwest of the California-Nevada state line from California Highway 127 toward the abandoned Tonopah and Tidewater Railroad tracks, Inyo Co., California, 11 June 1970.

Stanleya pinnata (Pursh) Britt. var. *inyoensis* (Munz and Roos) Reveal, stat. nov., based on *S. pinnata* ssp. *inyoensis* Munz and Roos, Aliso 3:115. 1965 $n=28$. Figs. 19, 20. Our counts are in agreement with those recently obtained from root tips by Rollins and Rüdenburg (1971). The voucher is *Reveal 2277*, Stewart Valley, Inyo Co., California, 12 June 1970.

Prunus virginiana L. var. *melanocarpa* (A. Nels.) Sarg. $n=8$. Figs. 21, 22, 23. This represents a new report, since no number for var. *melanocarpa* has been previously published. It is also a new count for the species, since the only report of var. *virginiana* we know of is $n=16$ (Sax, 1931), and such a count may raise some questions as to the relationship between the western American entities, var. *melanocarpa* and var. *demissa* (Nutt.) Sarg., and the eastern chokecherry, var. *virginiana*. More data are needed and hopefully can be obtained during the next few years. Our voucher is *Beatley and Reveal 11208*, Upper Eden Creek Canyon, east slope of the Kawich Range, Nye Co., Nevada, 15 June 1970.

Astragalus beatleyae Barneby. $n=11$. Figs. 24, 25. This new count joins those of two other species in subsection Aridi of the

section Inflati; all are $n=11$ (Barneby, 1964), which is the most common number in the North American species of the genus (see Bolkhovskikh et al., 1969). Our voucher of this recently proposed species (Barneby, 1970) is *Beatley and Reveal 10907*, flatrock area 2.8 miles north of Pahute Mesa Road on the Plateau Road, Pahute Mesa, Nye Co., Nevada, 4 June 1970.

Lupinus argenteus Pursh. $n=24$. Figs. 26, 27. This complex species is found throughout much of the western United States and is variously divided into species, subspecies, or varieties by several authors. C. P. Smith (1944) most likely called this plant *L. corymbosus* Heller. Later, these plants were called *L. alpestris* A. Nels. (Clokey, 1951) or *L. argenteus* var. *tenellus* (Dougl. ex G. Don) D. Dunn (Dunn, 1956). More recently, these plants have been referred to *L. argenteus* var. *stenophyllus* (Nutt. ex Rydb.) R. J. Davis (Beatley, 1969). We are still not clear what name should be applied to the collections from southern Nevada; *L. argenteus* is certainly the oldest name, although *L. alpestris* would have priority in our vicinity. The voucher is *Beatley and Reveal 10909*, south rim of Pahute Mesa, Nye Co., Nevada, 4 June 1970.

Lupinus aridus Dougl. ex Lindl. $n=12$. Figs. 28, 29. This species has been variously defined in recent years. C. P. Smith (1944) and Dunn (1956) have considered this form a distinct species, while Detling (1951), who monographed the group, referred *L. aridus* to a subspecific rank under *L. lepidus* Dougl. ex Lindl.; this latter treatment was followed by that of Hitchcock (1961), who used the varietal rank instead. To date, all entities referred to this species complex have had a single chromosome number, $n=24$. Among the related species are *L. lyallii* A. Gray [or *L. lepidus* var. *lobbii* (A. Gray) C. L. Hitchc.], $n=24$ (Phillips, 1957); *L. caespitosus* Nutt. ex Torr. and Gray [or *L. lepidus* var. *utahensis* (S. Wats.) C. L. Hitchc.], $n=24$ (Heiser, 1963); and *L. lepidus* itself, with $n=24$ (Phillips, 1957). Dunn has seen our voucher and other specimens from the same site and has identified our material as *L. aridus*. However, according to Detling's monograph, our material would be far out of the known range of the *L. lepidus* complex, the nearest confirmed site being in the high Sierra Nevada of California (*L. lobbii* A. Gray and *L. lyallii*) or in southeastern Oregon (*L. aridus*). One collection from northern Nye Co., Nevada, was tentatively assigned to *L. aridus* by Detling, but he was uncertain as to the exact identity of the collection. Based on the unusual chromosome number, geographical disjunction, and the observable morphological differences seen by both Beatley and Reveal, it would seem the plants from southern Nye Co., Nevada, may represent a new taxon. Our voucher is *Beatley and Reveal 11138*, southern Kawich Valley just below Gold Flat, Nye Co., Nevada, 14 June 1970.

Angelica kingii (S. Wats.) Coult. and Rose. $n=22$. Figs. 30, 31. This represents a new count for the species. Our voucher is *Beatley and Reveal 11284*, Cold Creek, eastern slope of Spring Mountains [Charleston Mountains], Clark Co., Nevada, 17 June 1970.

Gilia nyensis Reveal. $n=9$. Fig. 32. A new count. This recently proposed species (Reveal, 1969), found in sandy places in southern Nye Co., Nevada, is related to *G. hutchinsifolia* Rydb., which also is reported to be $n=9$ (Munz and Keck, 1959). The voucher is *Beatley and Reveal 11147*, Kawich Valley, Nye Co., Nevada, 14 June 1970.

Castilleja viscidula A. Gray. $n=12$. Figs. 33, 34. Our count agrees with that recently published by Holmgren (1971). Our voucher is the southernmost population of the species: *Beatley and Reveal 11068*, Kawich Range, northwest of Kawich Peak, Nye Co., Nevada, 6 June 1970.

Castilleja martinii Abrams var. *clokeyi* (Pennell) N. H. Holmgren. $n=12$. Figs. 35, 36. Our count represents a new ploidy level for var. *clokeyi*. Holmgren (1971) reported $n=24$ for plants gathered on the east slope of the Spring Mountains (*Holmgren and Reveal 2988*), while our count, which was obtained from specimens gathered on the west side of the same range, indicates a diploid situation. This polyploid condition is to be expected, since Holmgren reports $n=12$, 24, and 36 for var. *martinii*. The voucher is *Beatley and Reveal 11282*, Trough Springs, north end of Spring Mountains, Clark Co., Nevada, 17 June 1970.

Arnica parryi A. Gray var. *sonnei* (Greene) Cronq. in Ferris. $n=19$. Figs. 37, 38. Our count is the first reported for this taxon and represents a new ploidy level in the species. Ornduff et al. (1963) have reported var. *parryi* to be $n=$ ca. 36, so it is possible that the typical variant might be $n=38$, or twice the value found for var. *sonnei*. Our voucher is *Beatley and Reveal 10975*, near the stream at Longstreets Ranch, west of Kawich Peak, Kawich Range, Nye Co., Nevada, 6 June 1970.

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INCIDENCE OF SPOTTED FEVER IN WOOD TICKS OF UTAH RECREATIONAL SITES[1]

C. Selby Herrin[2]

ABSTRACT.— In 1964, 135 male and 223 female *Dermacentor andersoni* Stiles were collected at 48 national forest recreation areas in Utah. Using guinea pigs immunological tests were performed on each of 62 samples to determine the presence of the Rocky Mountain spotted fever rickettsia. Thirteen of the samples (21 percent) were positive. These 13 samples contained 35 males and 34 females yielding an infection rate of at least 3.6 percent, assuming one infected tick was in each sample.

The Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, has been recognized as the principal vector of Rocky Mountain spotted fever (RMSF) in the Rocky Mountain states since shortly after the turn of the century. Much human suffering and many deaths have resulted from this disease in Utah as well as throughout the western United States. The presence of *D. andersoni* in recreational sites of the foothills, canyons, and mountains of the West offers a potential threat to the health of man. Expanding human population and increasing use of recreational facilities enhances this potential.

A previous paper (Herrin, 1968) dealt with the prevalence of *D. andersoni* adults in national forest recreational sites of Utah. This research note reports the incidence of *Rickettsia rickettsi* (Wolbach) in adult ticks collected from these recreational areas.

Using a white flannel drag, 358 adult *D. andersoni* (135 males and 223 females) were collected from 48 recreational sites during the spring and summer of 1964. Ticks from 54 collections were divided into 62 samples, rinsed several times in sterile physiological saline, and preserved in vials of sterile, nonfat skim milk at below -30 C. Subsequently, the ticks were thawed, removed from the milk, triturated, and diluted with 10 ml of sterile, nonfat skim milk. One guinea pig per sample was inoculated with 1 ml of supernatant. Guinea pigs were observed for scrotal reactions, and rectal temperatures were taken every other day for 28 days. If the guinea pig died, a second was subsequently inoculated with the original supernatant. After 28 days, blood was taken and serum was extracted from the guinea pigs. Four complement fixation (CF) screen tests were performed on each sample, followed by an additional CF test to determine the antibody titer of positive samples. As a final test, all guinea pigs were inoculated with a lethal dose of virulent *R. rickettsi* to determine if they were immune to RMSF. In this test, one guinea pig per sample was challenged, and immunity was judged solely on survival.

Abnormal temperatures in guinea pigs resulted after injections of triturated tick material from 18 samples. Seven showed abnormally

[1]This paper is taken from a master's thesis submitted to the Department of Zoology and the Graduate School of Brigham Young University (1966).
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TABLE 1. Collections of *D. andersoni* adults determined to be positive for *R. rickettsi*.

National forest Recreational site	Collection date	Number and sex in sample	Complement fixation titer	Immunity test *
Cache				
Friendship and Spring	7 July	2M, 2F	32	+
Fish Lake				
Bowery	4 June	2M, 2F	64	+
City Creek	2 June	8M	128	+
		7F	0	—
Monrovian Park	2 June	6M	128	+
		12F	0	—
Ponderosa	2 June	7M	0	—
		10F	128	+
Manti-Lasal				
Manti Community	10 July	7M	128	+
		8M	0	—
		10F	0	—
		10F	0	—
Uinta				
Altamont	25 June	2M, 4F	64	+
Aspen Grove	25 June	2M, 5F	64	—
Mutual Dell	25 June	2M, 3F	128	+
Silver Lake Flat	25 June	1M, 4F	64	—
Timpooneke	25 June	4M	128	+
		11F	0	—
Whiskey Springs	10 June	2M, 3F	128	+
Wasatch				
Sunset	7 July	1F	128	+

* Legend: + = immune; — = susceptible.

high temperatures immediately and throughout the observation period, whereas 11 had an increase in temperature after several days. None demonstrated scrotal reactions or necrosis. Eight guinea pigs died within 3 to 14 days after inoculation. Thirteen of 62 serum samples (21 percent) yielded positive CF tests (see Table 1). The titers of these samples ranged from 1:32 to 1:128, whereas controls gave titers of 1:512. Eleven of 62 guinea pigs challenged with virulent spotted fever organisms survived, indicating immunity to RMSF. These 11 correspond with 11 of the 13 serum samples yielding positive CF results. In two cases of positive CF tests, guinea pigs were susceptible to the challenge. This close correlation between results of the CF tests and the immunity tests suggests that 11, and probably 13, tick samples contained *R. rickettsi.* Three of the CF positive guinea pigs showed slightly abnormal temperatures. The remaining 15, and possibly 18, instances of abnormal temperatures are not attributable to spotted fever, since there was no correlation between samples that showed positive CF and immunity tests. Of the eight guinea pigs that died, two were from samples deemed positive by CF and immunity tests. Observations made at necropsy indicated that death was probably caused by bacterial infection.

The 13 samples of ticks positive for spotted fever represented 69 ticks (35 males and 34 females). If each positive sample yielded one tick infected with spotted fever, then 3.6 percent of all ticks collected were infected. Infected ticks were from sites in the northern half of Utah near human population centers (Provo, Salt Lake City, Ogden, and Logan). Infected ticks were collected from early June to late July and from every elevation range at which collections were made (6000 to 8800 ft). Further studies relative to incidence and virulence of *R. rickettsi* in wood ticks would help to determine the enzootic status of RMSF in Utah. Such studies should include identification of *R. rickettsi* by fluorescent antibody staining and recovery of rickettsiae in egg cultures prior to immunological tests with guinea pigs.

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NOTES ON THE NESTING BEHAVIOR OF *STENIOLIA ELEGANS* (HYMENOPTERA: SPHECIDAE)

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Abstract.— The nesting behavior of a small aggregation of the digger wasp *Steniolia elegans* near Fort Collins, Colorado, is described. The prey was found to consist primarily of bee flies (Bombyliidae), the egg being laid erect on the first fly placed in the cell. Nests were shallow, unicellular, and were closed at all times when the female was away.

Several years ago Evans and Gillaspy (1964) reviewed what is known of the nesting behavior of digger wasps of the genus *Steniolia* (tribe Bembicini). One of the more common and widely distributed species, *elegans* Parker, was largely omitted from this review, since little was known concerning it. The present report is based on a two-day study of a nesting aggregation of this species just west of the city of Fort Collins, Colorado.

This aggregation was discovered on 4 July 1971 on the slag pile of an abandoned mine on a south-facing slope. There were an estimated 50 individuals of each sex. Males were most active during the morning (8:30 a.m.-12:30 p.m.), flying close to the ground in irregular patterns and landing here and there with their legs outstretched and their antennae extended rigidly forward. Now and then they hovered, with their middle legs extended, over females occupied at their nests, and on several occasions attempted copulations were observed.

The nests of the females were located in sloping, moderately friable but very stony soil. During the morning (9:30-11:30 a.m.) each female reopened her nest, first hovering over the entrance briefly and then digging through the closure, remaining inside for 20-60 seconds, then emerging and making a fresh closure. Then she hovered over the nest, flew off, and returned one or more times to hover again over the nest. These were evidently "inspection trips" serving to inform the wasp of the needs of the larva and perhaps to reinforce her memory of the nest site.

Within a few minutes to an hour or two following the inspection, each female returned with her first prey, carried with the middle legs in the usual manner of Bembicini. Prey-laden females produced a loud whine and often hovered briefly over the nest before digging through the closure. They remained in the nest very briefly (usually less than a minute) before coming out and restoring the closure. The prey consisted mostly of bee flies, as is common in the genus. The following species, in the numbers indicated, were taken from nests or from provisioning females (determinations by L. V. Knutson):

Bombyliidae	
Anthrax irroratus Say	1
Poecilanthrax signatipennis (Cole)	5

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Systoechus vulgaris Loew	4
Villa sinuosa Wiedemann	2
Villa spp.	8
Asilidae	
Holopogon atripennis Back	1
Syrphidae	
Eupeodes volucris Osten Sacken	1
Microdon coarctatus Loew	1
Volucella sp.	1

Provisioning was found to be fully progressive, the number of flies brought in per day being determined by the size of the larva. Nests dug out in the morning, before provisioning began, contained only the remains of flies.

Several females were seen starting new nests in the afternoon, after having made the final closure of their previous nests. Much use was made of the mandibles in breaking through the soil and in dragging pebbles from the burrow and depositing them on the mound. From time to time, the female backed out of the entrance scraping soil, then remained on the mound for a few seconds, turning to one side or the other while still scraping soil. As the burrow deepened, the wasp appeared less frequently (at 5- to 10-minute intervals), each time she appeared taking either a brief flight in a small loop or a much larger loop with a diameter of 3-6 meters. I observed no leveling movements following completion of the nest, and the mound of earth at the entrance was left intact, measuring about 3 cm wide by 4 cm long and 0.5-1.0 cm deep. Several hours were required for completion of a nest.

When the nest was finished, each female made a thick closure from the outside by digging into that portion of the mound close to the entrance. Thus, newly completed nests could be recognized by the fresh mound which had been dug away on one side, facing the covered entrance. The egg was found to be laid erect on the side of the initial fly placed in the cell, in the common manner of Bembicini.

Six nests were excavated, and all were found to be unicellular—a simple, oblique burrow leading to a terminal cell 4.5-9 cm deep (mean 6.6 cm). Some burrows were straight, while others were curved in various ways to avoid stones. Burrow length varied from 7 to 17 cm (mean 11 cm). None of the nests excavated appeared to be parasitized.

It was evident that wasps did not spend nights or rainy periods inside their nests, and it is known that this species forms clusters on vegetation in the manner of other *Steniolia* species (Evans and Gillaspy, 1964). However, an extensive search of surrounding terrain during the evening failed to reveal any such clusters.

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Evans, H. E., and J. E. Gillaspy. 1964. Observations on the ethology of digger wasps of the genus *Steniolia* (Hymenoptera: Sphecidae: Bembicini). Amer. Midl. Nat. 72: 257-280.

A TAXONOMIC REVISION OF *PHYSARIA* (CRUCIFERAE) IN UTAH

Sheldon B. Waite[1]

Abstract.— The *Physaria* species which occur in Utah are revised. This study is based on the treatment of this genus by Rollins (1939) and Mulligen (1967). Keys, descriptions, distribution maps, herbarium specimen citations, and discussions of the taxonomy of the genus are presented.

The genus *Physaria* is confined to western North America. It occurs in the upper sonoran, transition, montane, and lower Canadian life zones, chiefly on high plateaus and lower mountain elevations (Rollins, 1939). This distribution extends from the southwestern United States to the Canadian border and from the Great Plains to the Sierra Nevada and Cascade mountain ranges. The genus, according to Rollins (1939), is of very recent origin. Mulligen (1967) verifies this view with studies he conducted using chromosome counts. He infers from his chromosome studies that several species are so closely related that a single species could include them all. One such cluster includes three of the four species which occur in Utah: *P. acutifolia*, *P. chambersii*, and *P. newberryi*. The other closely related species which belong to the group are *P. didymocarpa*, *P. bellii*, *P. rollinsii*, *P. brassicoides*, *P. condensata*, and *P. floribunda*. Since morphological characteristics distinguish these groups and all species within them are virtually isolated geographically, Mulligen (1967) believes they should be retained as individual species.

Some integration can be observed morphologically in southern Utah between *P. chambersii* and *P. acutifolia*. Integration is also evident between *P. chambersii* and *P. newberryi* in the extreme southern counties of Utah.

Mulligen (1967) corrected the name applied by Rollins (1939) to the *Physaria* of eastern Utah from *P. australis* to *P. acutifolia*. This was due to specimens studied from Colorado which have since been named *P. rollinsii* (Mulligen, 1966).

Rollins described *P. chambersii* var. *membranacea* from specimens taken from Red Canyon, 16 miles west of Bryce Canyon National Park, Garfield County, Utah. The classification was based on the membranaceous nature of the siliques. Plants taken from this region and cultivated in different soils and environmental conditions showed a wide variation in the texture of the valves. Mulligen (1967) concluded that the specimens treated as var. *membranacea* did not, therefore, warrant varietal status.

Specimens examined in this study are in the herbaria of Brigham Young University (BRY), Utah State University (UTC), and the University of Utah (UT). Those labeled only as *Physaria* sp. were lacking fruits and were not included in citations.

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Physaria inhabits dry barren regions where sunlight is intense and competition is minimal. The adaptation of this plant to survive xeric conditions is reflected in the heavy pubescence on the gray green leaves.

Physaria (Nutt.) Gray

Perennial, caespitose, silvery stellate; stems simple, arising laterally on a somewhat elongated caudex; basal leaves usually numerous, often terminating the caudex or its branches in rosette form, petiolate oblanceolate to obovate or the blade rotund, entire dentate, or divided into segments; cauline leaves present, usually few, entire or dentate; inflorescence congested to somewhat elongated, usually elongating in fruit; pedicels rigid; sepals linear-oblong, pubescent, often cucullate at apex; petals yellow or rarely purplish, usually spatulate, glabrous; siliques didymous, pubescent, often highly inflated, apical sinus present; ovules 2-6 in each loculus; style persistent; seeds brown wingless.

Key to the Species Known in Utah

1. Style less than 3.5 mm long .... *P. newberryi*
   Style more than 4 mm long 2

2(1). Sinuses of silique equal above and below, valves nearly orbicular .... *P. acutifolia*
   Sinuses of silique equal above and below, valves not as above 3

3(2). Silique highly inflated, 1.5-3 cm wide, valves membranaceous .... *P. chambersii*
   Silique moderately inflated less than 1.5 cm, plants loosely pubescent .... *P. grahamii*

Physaria acutifolia Rydb.

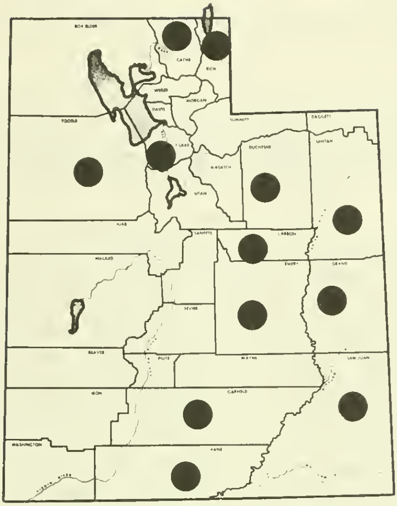
Physaria acutifolia Rydb., 1901, Bull. Torr. Bot. Club 28:279.

Physaria didymocarpa (Hook.) Gray var. *australis* Payson, 1918, Ann. Gard. 5, 144.

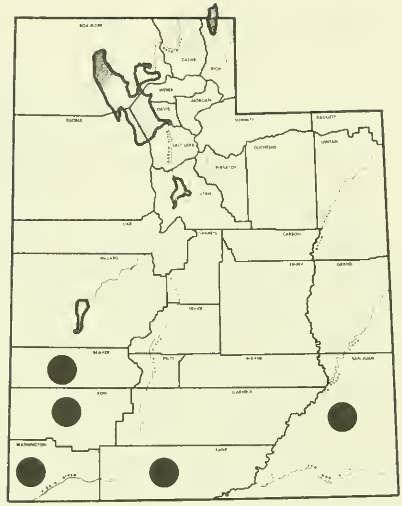
Physaria australis (Payson) Rollins, 1939, Rhodora 11, 408.

Description.— Small, tufted perennial with a deep, rather slender taproot; basal leaves numerous 1.5-2 cm long, oblanceolate or obovate, acute entire or slightly wavy and very finely stellate stem; leaves rather few, oblanceolate; flowering stems 4-6 cm long, ascending or depressed; fruit small, obtuse or slightly cordate at the base, deeply divided above; cells inflated almost spherical, 4-6 mm in diameter; style about 5 mm long. This species differs from *P. didymocarpa* in its smaller acute leaves and in its smaller fruit, which is more deeply divided above as well as below.

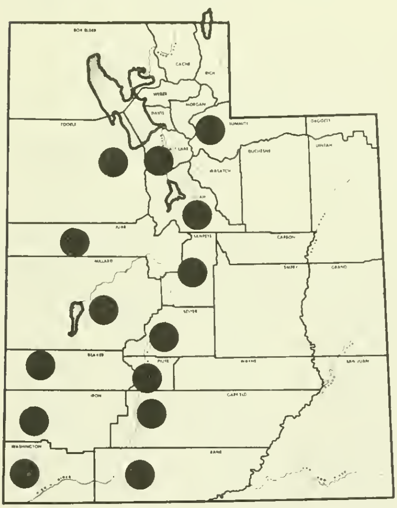
The siliques are characteristic features of this species, being highly inflated and strongly contracted toward the replum. The



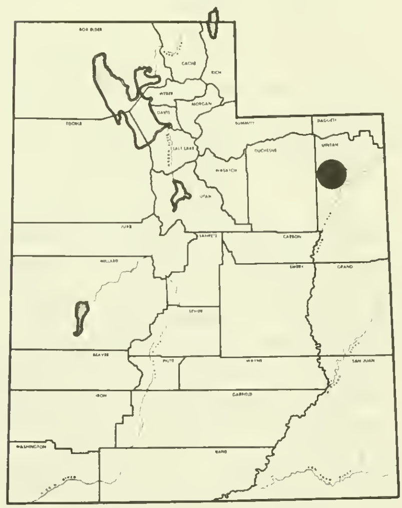
1. Physaria acutifolia Rydb.



2. Physaria newberryi Gray



3. Physaria chambersii Rollins



4. Physaria grahamii Morton

Figs. 1-4. *Physaria* distribution in Utah: 1, *P. acutifolia* Rydb.; 2, *P. newberryi* Gray; 3, *P. chambersii* Rollins; 4, *P. grahamii* Morton.

apical and basal sinuses are well developed and almost equal. The valves are rounded.

Distribution.— This species grows in eastern Utah in dry, sparsely populated plant communities at ranges from 2,000 feet up to 9,000 feet in elevation. Members of the genus are found outside of Utah in northwestern New Mexico, western Colorado, southeastern Idaho, and most of Wyoming.

Specimen citations include the following counties: Grand, B. F. Harrison 5968, 9-V-1933 (BRY); San Juan, S. L. Welsh 2898, 31-V-1964 (BRY); Uintah, S. L. Welsh 49, 29-IV-1955 (BRY); Emery, B. F. Harrison 8076, 8-V-1936 (BRY); Kane, J. R. Murdock 403, 3-V-1962 (BRY); Carbon, N. D. Atwood 1300, 29-IV-1968 (BRY); Garfield, B. Maguire 19,098, 25-VI-1940 (UTC); Duchesne, A. O. Garrett 7784, 19-VII-1938 (UT); Salt Lake, A. O. Garrett 6355a, 28-VI-1933 (UT); Tooele, J. Reveal 191A, 15-VI-1961 (UTC); Rich, J. W. Harrison no number, 24-VI-1927 (UT) (labeled as Cache County); and Cache, S. Flowers 223, VI-1924 (UT). Note: The University of Utah specimens used here were labeled by the previously used name of *P. australis* or, in some instances, by the name of *P. didymocarpa*, which is not known to grow in Utah.

Physaria newberryi Gray

Physaria newberryi Gray, 1860, in Ives' Report Colo. River, pt. 4, 6.
Coulterina newberryi (Gray) O. Kuntze, 1891, Revis. Gen. 2, 931.
Physaria didymocarpa (Hook.) Gray var. *newberryi* (Gray) Jones, 1895, Proc. Calif. Acad. Sci. 2, 5.

Description.— Perennial, caespitose, silvery stellate throughout; caudex simple branched; stems several to numerous, erect, simple, arising laterally, 0.5-1 dm long including the fruiting raceme; basal leaves obovate, incised, or merely dentate with broad teeth, slender petioled, 4-8 cm long, 3-4 mm wide; petals yellow ligulate, often truncate at apex, 10-13 mm long, 2-3 mm wide; fruiting raceme dense, 3-5 cm long; pedicels rigid, straight, divaricate, 5-10 mm long; siliques didymous, highly inflated, apical sinus broad, the shoulders angular and evenly compressed with appressed stellae; valve keeled on both outer margins, each valve 8-12 mm wide, 12-16 mm long; replum linear, acute at apex, 8-10 mm long, 1-1.5 mm wide; style 2-3 mm long; ovules 2-4 in each locule; seeds obovate, light brown marginless, 2-3 mm wide, 3-4 mm long.

Distribution.—This species is found only in the extreme southern part of Utah growing in dry, open areas. It is found in north central and northern Arizona and in the extreme northwestern part of New Mexico. The distinctive characteristics of this species are its V-shaped apical sinus, short style, and straight-sided silique.

Specimen citations include the following counties: Washington, S. L. Welsh and G. Moore 6865, 6-IV-1968 (BRY); Iron, W. P. Cottam 4724, 22-IV-1930 (UT); San Juan, B. F. Harrison 11600, 19-V-

1950 (BRY); Kane, Cottam 4289, 12-VI-1929 (BRY); and Beaver, Cottam 8032, 8-VI-1940 (UT) (labeled as *P. didymocarpa*).

Physaria chambersii Rollins

Physaria chambersii Rollins, 1939, Rhodora 41, 403.
Physaria chambersii var. *membranacea* Rollins, 1939, Rhodora 41, 405.

DESCRIPTION.— Perennial, caespitose, silvery stellate throughout; stems numerous from a simple caudex, arising laterally, erect or very often decumbent, simple, 5-15 cm long including the fruiting raceme; radial leaves entire or dentate, obovate to orbicular, slender petioled, 3-6 cm long, 1-2 cm broad; cauline few, entire, spatulate, often acute, 1-2 cm long, 3-6 cm wide; inflorescence rather lax; sepals linear-oblong, pubescent 6-8 mm long, 1 mm wide; petals yellow, spatulate, 10-12 mm long, 3-4 mm wide; fruiting raceme congested, 2-10 cm long; pedicels divaricate, slightly sigmoid, 8-15 mm long; siliques didymous, greatly inflated, evenly and often densely pubescent, often purplish at maturity, obtuse to slightly cordate at base; apical sinus deep and open, crests rounded; valves subreniform, each valve 1-1.5 cm long, 1 cm wide; style 6-8 mm long; ovules 2-6 (mostly 4) on each side of the replum; seeds orbicular, flattened brown, 2-3 mm broad, 2-4 in each loculus margin.

P. chambersii is related to *P. newberryi* but differs in having round-sided siliques and apical margins, a cordate or nearly truncate base, sinus crests rounded, style 8-13 mm long and replum 3-6 mm long compared to keeled apical margin siliques, truncate base, sinus crests decidedly angular, style 2-3 mm long, replum 8-10 mm long with acute apex and straight-sided valves for *P. newberryi*.

DISTRIBUTION.— This species is found in the western half of Utah, most of Nevada, northwestern Arizona, extreme southeastern Oregon, and southwestern California.

Specimen citations include the following counties: Utah, B. F. Harrison 8326, 18-V-1938 (BRY); Juab, W. P. Cottam 7187, 28-V-1937 (UT);* Tooele, C. Edwards 123, 15-V-1968 (BRY); Garfield, W. O. Stanton 153, 28-VI-1930 (BRY); Sanpete, A. O. Garrett no number, 29-IV-1911 (BRY); Kane, Cottam 4289, 12-VI-1929 (UT); Summit, S. L. Welsh 6263, 20-VI-1967 (BRY); Millard, W. P. Cottam 7347, 14-V-1939 (UT);* Washington, P. Plummer 5429, 9-V-1939 (UT);* Sevier, R. Stevens 134, 10-IV-1966 (BRY); Beaver, M. Milner 9212, 30-IV-1946 (UT); Iron, Cottam 3922, 31-V-1926 (BRY); Piute, W. P. Cottam 7005, 15-V-1936 (UT);* and Salt Lake, S. Flowers 1390, 1927 (UT). Plants marked with an asterisk(*) were mislabeled as *P. didymocarpa*.

A specimen labeled A. O. Garrett 8333a, 9-VI-1940 (UT), from Duchesne County, was sent to Reed Rollins, who stated in a letter now in the herbarium that this is a new species closely related to *P. oregoni* or a variety of the same. However, *P. oregoni* is found no farther south than central Idaho. No further information was available concerning this specimen.

Physaria grahamii Morton

Physaria grahamii Morton, 1937, in Ann. Carneg. Mus. 26:220.

Description.— Perennial, caespitose, densely pubescent throughout with spreading stelae; stems simple, somewhat decumbent, about 1.5 dm long; basal leaves numerous, broadly oblanceolate to broadly spatulate, obtuse irregularly pinnatifid, 10-15 cm long, about 3 cm broad, distal lobes large and variable, cauline, few, dentate or rarely entire; pedicels divergent, 5-15 mm long; sepals linear-oblong, pubescent, about 5 mm long; petals yellow, spatulate, 6-8 mm long; siliques erect, didymous, inflated but not highly so, shallow sinus below, deep sinus above; replum linear-oblong, somewhat constricted, ovules 2 on each side; style 6-8 mm long; mature seeds unknown.

The type of this species is not altogether satisfactory because the fruits are immature. Its distinctiveness rests upon the fact that the entire plant is covered with loose, spreading stelae and large basal leaves deeply lobed along the margins. *P. grahamii* is at present known only from the type collection.

Distribution.— This species is known from specimens collected at Chandler Canyon, Uinta Basin, Uintah County, Utah, 3-VIII-1935. Graham 9976 (US type).

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TWO NEW SPECIES OF *GYMNODAMAEUS* FROM COLORADO (ACARINA: CRYPTOSTIGMATA, GYMNODAMAEIDAE)[1]

Tyler A. Woolley[2] and Harold G. Higgins[3]

Abstract.— *Gymnodamaeus plokosus* and *G. leurolomasus*, n. spp., are described from soil at an ecological study site near Hayden, Colorado. Their relationship to allied species is discussed.

A review of the literature indicates that the first species of *Gymnodamaeus* were described by Berlese (1910, 1916). Woolley (1972) reviews the literature of known soil mites in the genus *Gymnodamaeus* and describes a new species, *Gymnodamaeus chalazionus*, from the mountainous areas of northern Colorado. The two new species described below are additions to this genus.

The specimens of the first species described below were taken in soil beneath sage and grass along the undisturbed margin of a spoil bank near one of the coal strip-mining sites of the Hayden, Colorado, power plant. Comparisons of these specimens with others in the collections of the writers and with descriptions in the literature indicate that the species is new. It is described below and compared with other known species.

Those species of *Gymnodamaeus* from North America with which this new species were compared are *G. veriornatus* Higgins, 1961, and *G. chalazionus* Woolley, 1972. The new species is smaller in size than the above species but averages very close to the size of *G. gildersleeveae* Hammer, 1952, and *G. elegantulus* Hammer, 1958; it is smaller than *G. minor* Banks, 1947, slightly larger than *G. pearsei* Banks, 1947, and much larger than *G. quadricaudiculus* Jacot, 1937. The details of this size comparison are given below with collection data and measurements of the new species.

Gymnodamaeus plokosus, n. sp.

(Figs. 1, 2)

Diagnosis.— Most easily recognized by the crenulated posterior margin of notogaster with four nubbins, each bearing an ornate, curved hair (Figure 1); differs from *G. gildersleeveae* Hammer, 1952, in this feature as well as in the marginal placement of the posterior notogastral hairs; without reticulate pattern on dorsum of notogaster as in *gildersleeveae*, but with an arched, transverse bar on prodorsum just anterior to interlamellar hairs which is not present in *gildersleeveae*. Differs from *G. quadricaudiculus* Jacot, 1937, in the absence of the dorsal oval sculpturing with rays. The interlamellar hairs of the new species are short and most nearly resemble

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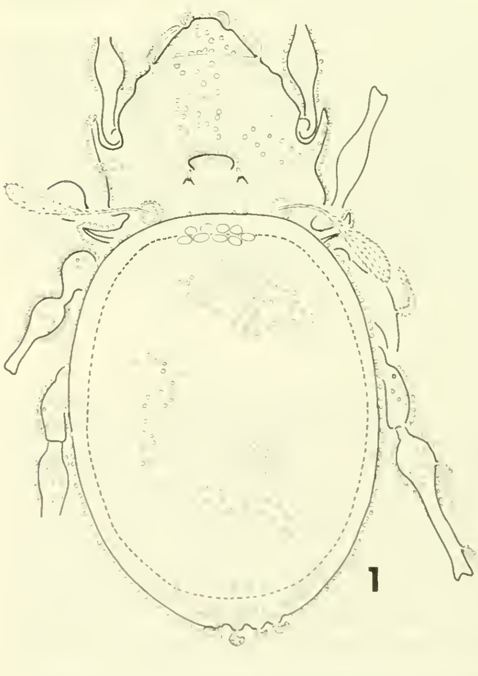
those of *G. chalazionus* Woolley, 1972. The sensillum of the new species is most similar to *G. gildersleeveae*, broadly flabelliform and spined for its entire length.

The trivial name *plokosus* is from the Greek, meaning "a lock of hair," or "curled," and refers to the four ornate, posterior notogastral hairs that arise from the nubbins and are so characteristic of the species.

Description.— Color golden brown with a tuberculated, yellowish cerotegument giving a halo effect around the margins of body and legs; this cerotegument on prodorsum, notogaster, venter, legs, prodorsal hairs (except for interlamellar hairs), and notogastral hairs; prodorsum less than half as long as notogaster, broadly triangular in shape, with blunt, squarish rostrum; rostral and lamellar hairs of about equal length, decurved, covered with tuberculated integument; rostral hairs inserted in slight notches in anterolateral margin of prodorsum; lamellar hairs inserted in short apophyses at lateral margins, a transverse, sclerotized bar extending between insertions, hairs also covered with tuberculated integument, but tubercles of minute size compared to those of prodorsum; an arched, slightly U-shaped bar in posterior third of prodorsum immediately anterior to interlamellar hairs, extending in width about distance between interlamellar hairs; interlamellar hairs short, simple, in-



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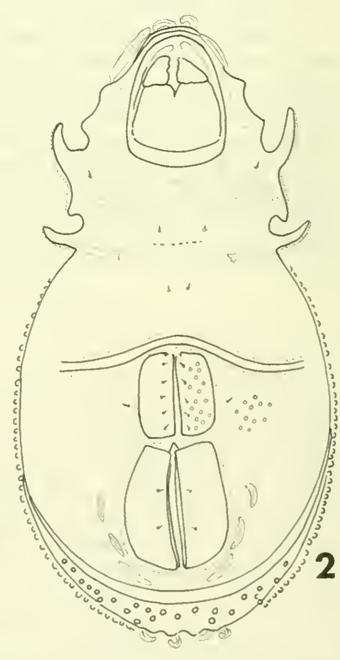

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Figs. 1-2. *Gymnodamaeus plokosus*: 1, dorsal aspect, legs partially omitted; 2, ventral aspect, legs omitted.

serted in inverted V-shaped apophyses posterolaterad of arched bar; pedotecta I and II as in Figure 1, with tuberculated surface due to cerotegument; pseudostigmata rounded, cup-shaped, with lip raised above surface of prodorsum, covered externally and internally with small tubercles; sensillum flabelliform, flattened in one plane, head broad, pedicel narrow, spined throughout length.

Notogaster oval in shape, with nearly straight anterior margin; surface covered with tuberculated cerotegument; 8 to 10 large, more flattened tubercles near median area of anterior margin, other tubercles of surface smaller, more rounded; four short, sclerotized nubbins posteriorly, forming a crenulated posterior margin; each nubbin with an inserted curved, ornate hair covered with small tubercles, a similar, less curved hair anterolaterad of nubbins on each side (placement of these six hairs apparently a specific characteristic in species of *Gymnodamaeus*); other hairs and surface features as in Figure 1.

Camerostome somewhat triangular, with heavily sclerotized margins; ventral setae, apodemata as seen in Figure 2; ventral surface with tubercles, but ventral tubercles only a third as large as dorsal tubercles; ventral setae simple, short; apodemata IV arched anteriorly over genital opening as in other species of *Gymnodamaeus;* genital and anal openings contiguous throughout widths; genital covers with cerotegument of tubercles, each cover with six genital setae; aggenital setae short, simple, laterad of genital opening; anal covers with tubercles, each cover bearing two simple anal setae; adanal setae ornate, covered with cerotegument of smaller tubercles (Figure 2).

Legs heterotridactylous; surface of legs covered with cerotegument similar to dorsum; hairs of legs also covered with tuberculated cerotegument, but tubercles of proportionately smaller size.

COLLECTIONS AND MEASUREMENTS.— Ten males and two females of *G. plokosus* were collected by the writers at the Seneca site number 2, Hayden, Colorado, 10-IV-1971. The males ranged in size from 432-372 μ x 216-186 μ, with an average of 399 μ x 207 μ. Four females and three males were collected from the same site on 8-VI-1971 by the writers. These males ranged in size from 420-408 μ x 210-204 μ, averaging 410 μ x 208 μ. The females ranged in size from 444-420 μ x 238-210 μ, with an average size of 432 μ x 228 μ.

Additional specimens were taken in the project areas as follows: 3 males (425-415 μ x 212-205 μ) from under scrub oaks, 4 miles N Seneca Road, 1-VIII-1971, by H. G. Higgins; 2 males (425-430 μ x 210-205 μ) from under chokecherries, one-fourth mile N Hayden Power Plant, 1-VIII-1971, by H. G. Higgins; 1 male specimen (395 μ x 205 μ) under serviceberry on spoil bank, 10-IV-1971, by H. G. Higgins and T. A. Woolley; 1 male (380 μ x 210 μ) from beneath sagebrush, two miles S Yampa Valley Airport, 9-VI-1971, by H. G. Higgins and T. A. Woolley. Three specimens (2 females and 1 male) of this species were collected at Terry Falls, Trail Lake Ranch, Dubois, Wyoming, 20-VII-1964, by H. and M. Higgins. They ranged in size from 432-420 μ x 210-204 μ. A single specimen was

also collected by H. and M. Higgins at Soapstone, Wasatch County, Utah, on 4-IX-1955. The specimen is so broken, however, that sex and size are not distinguishable. Two females were collected by T. A. Woolley in South Dakota, one (426 μ x 204 μ) at Black Hills, 28-VIII-1968, and one (426 μ x 316 μ) in the Nordbeck Game Preserve, 28-VIII-1968.

The measurements of the width of all measurable specimens were taken at the level of legs IV. Generally speaking, females appear to be larger and more elongated in shape than males.

The drawings were made of a male specimen collected 10-IV-1971. The type and a paratype specimen will be deposited in the U.S. National Museum.

The second new species was collected in soil beneath aspens and scrub oak in an undisturbed area about four miles south of the spoil banks mentioned above. Compared to *G. plokosus*, it is much larger.

Gymnodamaeus leurolomasus, n. sp.

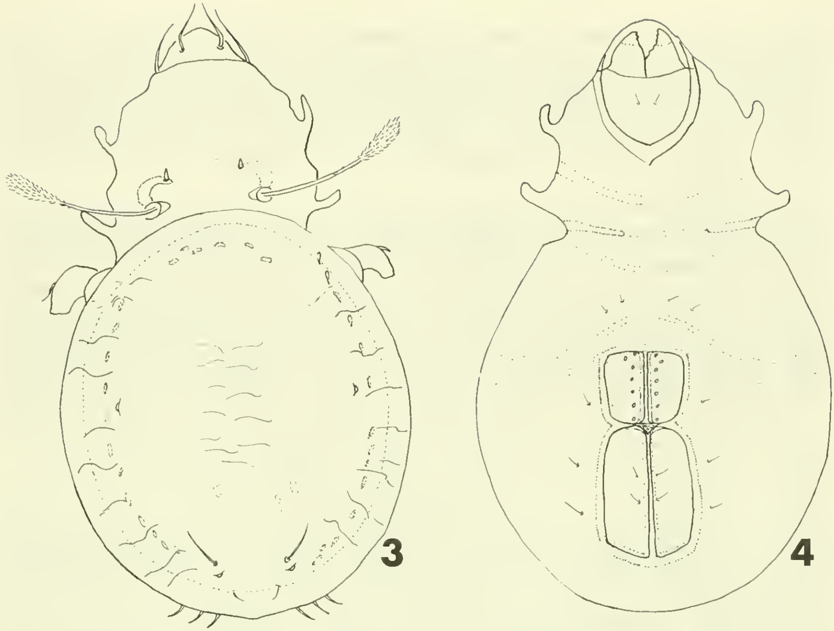
(Figs. 3, 4)

Diagnosis.— Larger size (.70 mm) median edge of genital plate smooth, lacking the interlocking dentes found in both *G. chalazionus* and *G. veriornatus;* each genital cover with seven setae; entire body and setae covered with a fine, granular cerotegument. The words *leuros* 'smooth' and *loma* 'border,' from the Greek, refer to the smooth median edge of the genital covers. This feature, along with the seven pairs of genital setae, distinguishes the new species from the other larger representatives of *Gymnodamaeus* from North America.

Description.— Color dark reddish brown, entire dorsal and ventral surfaces covered with a granular cerotegument; prodorsum about half as long as notogaster, broadly triangular in shape; rostral and lamellar setae about equal in length, rostral setae inserted dorsally, posterior to rostral margin but anterior to transverse sclerotized line between lamellar hairs; interlammellar hairs short, simple, conical, each inserted near tip of curved, sclerotized, median ridge anterior to pseudostigmata; in some specimens, a faint, transverse, curved sclerotized bar can be seen anteriomediad of interlamellar hairs (Figure 3); costulae absent; pseudostigmata rounded, with edge erected above surface of prodorsum; sensillum clavate, surface of club spined; entire organ slightly longer than prodorsum.

Hysterosoma longer than wide, with a wrinkled surface; posterior margin with six setae and two pairs of dorsal setae of different sizes, with muscle scars and pores as shown in Figure 3; no distinct dorsal ornamentation as seen in *G. veriornatus* Higgins or *G. ornatus* Hammer.

Camerostome oval in outline, mentum broad, rutella narrowed anteriorly; ventral surface with apodemata and setae as shown in Figure 4; genital and anal apertures contiguous; genital covers smooth on medial edge, each cover with seven simple setae; anal covers much longer than wide, each cover with two simple setae;



Figs. 3-4. *Gymodamaeus leurlamasus*: 3, dorsal aspect, legs omitted; 4 ventral aspect, legs omitted.

entire ventral surface covered with a granular cerotegument that obscures the location of coxisternal setae.

Legs long, surface and hairs covered with cerotegument; all legs heterotridactylous, median claw larger than laterals.

Collections and measurements.— Length, .65-.70 mm; width, .36-.41 mm. The type, a male, and eight other paratype specimens (six males, two females) were taken from under quaking aspens, 4 miles S Seneca Road, Hayden, Colorado, 8-X-1971, by H. G. Higgins. Five specimens were taken from under scrub oaks associated with aspens, 4 miles S Seneca Road, Hayden, Colorado, 1-VIII-1971, by H .G. Higgins. The type and one paratype will be deposited in the U.S. National Museum.

Discussion and Ecological Notes

It is interesting that two species of smaller *Gymnodamaeus*, *G. gildersleeveae* and *G. plokosus*, should be found in the project area. The latter species was first found under sagebrush along the edge of a spoil bank in rather dry soil. Subsequent collections have shown that this species is fairly well distributed throughout the western United States (Colorado, North Dakota, Utah, and Wyoming) as well as being found in the litter of several plant communities. For example, *G. plokosus* has been taken in rather dry soil and litter

under scrub oaks, serviceberry, sagebrush, and chokecherry in the Hayden project area. *G. gildersleeveae* has been found only under quaking aspens or in more moist scrub oak litter closely associated with aspens. This suggests that the populations of *G. gildersleeveae* prefer a more humid habitat, while *G. plokosus* is found mainly in a drier habitat.

Gymnodamaeus leurolomasus must be listed among the larger North American members of this genus, but it is smaller than either *G. veriornatus* or *G. chalazionus.* It is nearer the size of *G. ornatus* Hammer from Canada but lacks the dorsal ornamentation so well known for that species. It differs from both *G. veriornatus* and *G. chalazionus* in that it lacks the interlocking dentes on the median edges of the genital plates and possesses seven pairs rather than six pairs of genital setae. This disparity in the number of genital hairs is considered a specific characteristic, inasmuch as the generic features match other representatives known from North America.

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NEARTIC DESERT DECTICIDAE (ORTHOPTERA). PART II. A NEW GENUS AND SPECIES FROM ARIZONA

Ernest R. Tinkham[1]

ABSTRACT.— *Platyoplus*, n. gen., is erected for *P. gilaensis*, n. sp., from the Gila Mountains, Yuma Co., Arizona. The method of preservation for these large, soft-bodied insects is described.

The genus and species herein described was discovered in the Gila Mountains, 20 miles east of Yuma, Arizona, on 26 April 1958. The first specimen, found in a crevice of a giant boulder on a rocky ridge, eluded capture; however, other specimens were taken later.

Platyoplus, n. gen.

This new eremophilous, xerophilous, and petrophilous genus portrays characters that would place it between *Ateloplus* Scudder and *Inyodectes* Rentz and Birchim, with closest relationships indicated to *Ateloplus*. There appears to be little relationship shown to *Eremopedes* Cockerell and *Pediodectes* Rehn and Hebard. A review of the cercal features found in *Ateloplus* shows that four species, namely, *notatus*, *luteus*, *hesperus*, and *splendidus* have rather slender cerci with inner apical uncinate hook, while *minor* and *schwarzi* have shorter, quadrate cerci with inner apical tooth. The cerci of *Platyoplus*, with an inner subapical projection with uncinate tooth, is somewhat like that in *Oreopedes* Rehn and Hebard but is amply distinct in many ways. On the other hand, the features of the pronotum are quite atelopoid in nature; but even here the diagnostic differences are the shallower lateral lobes, which are quite outwardly flared and with those portions of the lateral lobes of the metazona tumidly raised and semitransparent above the greatly enlarged tympanum, which in itself is diagnostic for the genus. Such features, the writer believes, warrant generic recognition. Experience based on many years of study convinces the author that any member of a particular genus must have the same characters as the other species of that genus. Thus the cercus of *Ateloplus* has an inner apical tooth, whereas in other genera such as *Platyoplus* and *Eremopedes* the inner cercal tooth is subapical or intermediate in position, although in some *Eremopedes* the cercus is also undulate and quite distinctive in character. Likewise, the pronotum in the various genera such as *Platyoplus*, *Ateloplus*, *Eremopedes*, *Pediodectes*, *Inyodectes*, and *Oreopedes* are different in each genus. Added to these and other characters not mentioned is the true tympanum, which is distinctive in the various genera mentioned above and portrays its greatest development in *Platyoplus*.

Description.— Head broad and rather shallow, face with greatest breadth just below compound eyes, its breadth 1¼ times depth

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from vertex to clypeal suture. Fastigium with frontal costa broad, flat, abruptly terminated intermediately between the antennal sockets.

Pronotum diagnostic, flat and broad, its breadth equal to its length, with shallow, reflexed lateral lobes; metazona shorter than prozona, its lateral lobes tumidly swollen over upper half of greatly enlarged true tympanum.

Penultimate abdominal notite, with shallow U-shaped median groove. Cerci moderately slender, with an inner quadrate subapical prominence bearing an uncinate hook.

Legs average, strong; caudal femora stout and shorter than in related genera, with both ventral keels bearing six widely spaced teeth in the apical half. Caudal tibiae fully spined, with numerous teeth along the entire ventral keels and with four pairs apically on the upper carinae of the caudal tibiae.

Ovipositor stout, apical portion very slightly recurved, apex barely surpassing geniculae of caudal femora. Subgenital plate with a small, V-shaped median notch situated apically in the male; in female, deep median emargination, its margins very strongly raised with keels continuing basadly and convergent with an additional very high and narrow median keel connecting from base of deep, U-shaped emargination to base of plate; this character quite diagnostic for genus and not observed in related genera.

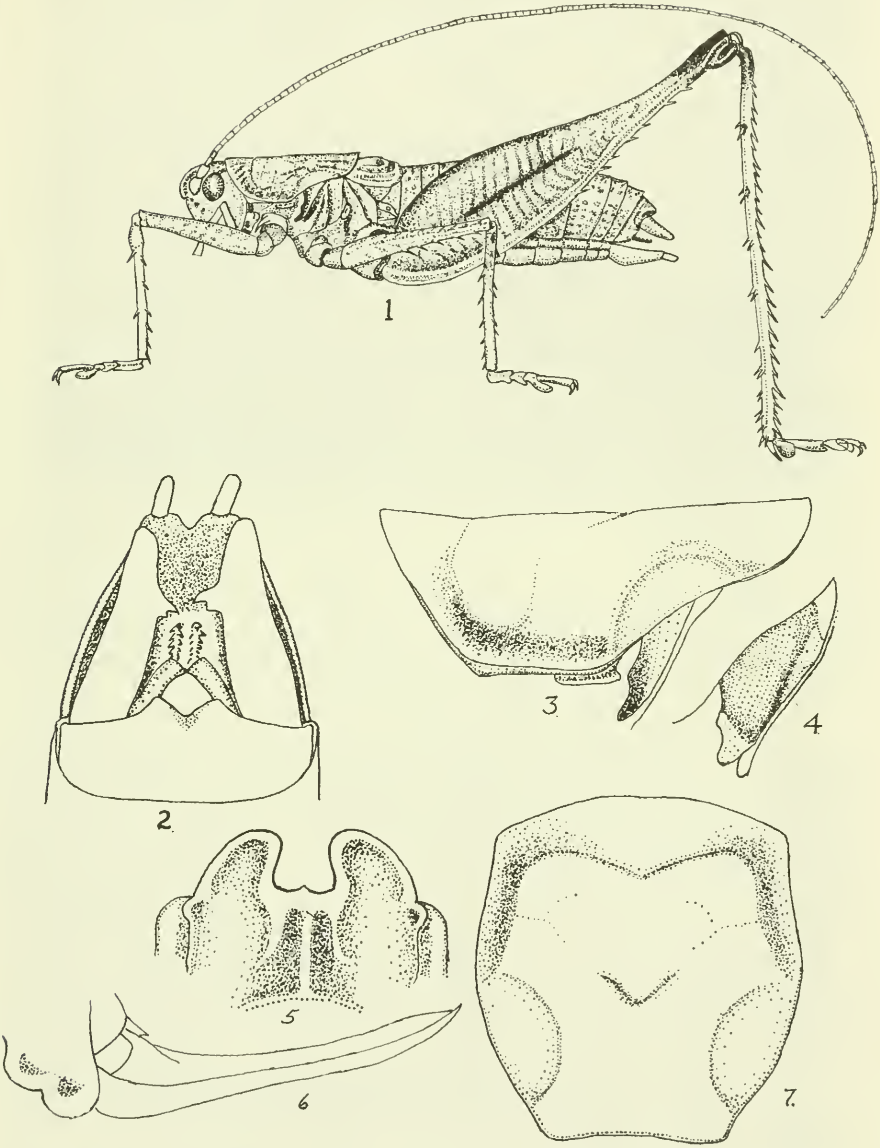
Coloration pale brownish with very fine mottling of pale purplish dots and with genicular areas of caudal femora black.

Type species.— *Platyoplus gilaensis* Tinkham, by monotypy. This genus is named after the very broad and flat pronotum which partially hides the very large true tympanum. The species is named after the Gila Mountains, that barren range of rocks about 20 miles east of Yuma, Arizona.

Platyoplus gilaensis, n. sp.

Description.— Male: head concolorous, unmarked; eyes subglobose, their depth about equal to their breadth. Antennae fully twice body length. Head broad and short, facial breadth just below compound eyes 1¼ times depth from vertex to clypeal suture. Fastium angularly rounding into flat and smooth frontal costa, its margins convergent forward and roundly terminated medianly between antennal sockets.

Pronotum diagnostic, quite flat with breadth equal to length, very shallowly rounded into flaring lateral lobes; metazona nearly flat due to tumid swelling of metazonal lobe above upper half of greatly enlarged true tympanum; tympanum broadest in its apical half under swollen metazonal flange. Metazona shorter than prozona; prozona with a prominent but shallow, very broadly V-shaped sulcus, about two-fifths of prozonal length posteriad of anterior margin. Anterior margin of the pronotum very smoothly arcuate for its entire breadth to the anterior lateral angle of lateral lobes; posterior margin almost squarely truncate, with at most only a slight sugges-



Figs. 1-7. *Platyoplus gilaensis* Tinkham: 1, Male holotype, profile view; 2, Genitalia of male holotype showing notite, cerci, titillators and subgenital plate; 3, Lateral view of pronotum of male holotype; 4, Tympanum of male holotype from ventrolateral aspect; 5, Posterior portion of subgenital plate of female allotype; 6, Lateral view of ovipositor of female allotype; 7, Dorsal aspect of pronotum of male holotype.

tion of emargination. Lateral lobes, seen from above, arcuately rounded, metazonal area outwardly bowed due to convexity of metazonal lateral lobe area above enlarged tympanum—a feature distinguishing *Platyoplus* from all other desert decticids. Tympanum very large.

Entire body surface smooth. Abdomen with ultimate notite bearing a moderate, median, V-shaped notch. Cercus moderate in build, broadest at base and very slightly tapered to apical two-thirds, inner margin of this area with a quadrate projection bearing a small, inner, slightly uncinate tooth. Subgenital plate with posterior lateral margins straight and with a median, posterior, V-shaped notch flanked outwardly with a short stylus. Plate distinguished further by a prominently rounded ridge extending anterior-laterally from base of each stylus, the ridges merging with basal portions of plate.

Wings exposed for a length equal to that of the metazona.

Forelegs with prominent procoxal spur; profemora with one to three very small inferior spines on exterior margin (leg forward) and four slightly larger spines on inner ventral keel. Protibiae with six or seven usually paired larger spines on ventral keels and two outer external spines dorsally, one of which is basal. Mesoleg without mesocoxal spine; mesofemora with five outer and two inner subapical small spines on ventral keels (legs in backward position); mesotibiae with six pairs of ventral spines and two pairs dorsally, as in protibiae. Hind legs with caudal femora bearing six spines on each ventral keel. Caudal tibiae heavily spined; 27-28 external and 24-26 internal strong spines on ventral keels and eight outer and inner attingent, widely spaced, slender spines on upper keels (ventral in position on folded legs). All tarsi three-segmented.

Living Coloration (notes made 1965): Head with face faintly purple gray; eyes with incomplete cross-striations of purplish brown. Antennae reddish brown, nodes narrowly ringed in darker reddish brown. Pronotum dull grayish brown, tinged more definitely with burnt umber on central portions of metazona and more narrowly on front central edge of prozona. Tegmina pale purplish gray, with cells in exposed central portions piceous. Abdomen above citrus yellow, profusely and finely mottled with dark purplish brown, posterior marginal areas with about 12 washed or running spots of dark reddish brown. Sternites of thorax and abdomen citrus yellow. Fore and middle legs pale reddish brown; caudal femora pale reddish brown, outer pagina with a single central piceous band heaviest posteriorly; geniculae and pregenicular area dark piceous or almost black; spines of lower keel dark reddish brown. Caudal tibiae pale reddish brown, piceous at extreme base with both dorsal spine rows tipped in apical half with reddish brown; fewer scattered ventral spines similarly colored.

Female: Slightly larger than male, but otherwise closely similar in coloration and spination of legs. Ovipositor slightly shorter than length of abdomen, rather heavy in build and very gently recurved, apex of ovipositor barely exceeding apices of caudal femora. Subgenital plate diagnostic, with a large and deep quadrangular emargi-

Fig. 8. Photograph of living *Platyoplus gilaensis* Tinkham on rock of native habitat.

nation occupying two-fifths of total length of subgenital plate. Lateral margins of emargination prominently raised and extending basadly to terminate in an arcuate fashion about half the distance to base of plate, plus a prominent median keel running from center of quadrangular emargination to base of subgenital plate.

HOLOTYPE.— Male, Telegraph Pass, Gila Mountains, Yuma County, Arizona, 20 miles E Yuma, Arizona, 800 ft elevation, 30-V-1965 (night collecting on Creosote *Larrea divaricata* on steep rocky slopes; Ernest R. Tinkham). Caliper measurements in mm: body length 22.0; pronotum 7.75 long x 7.2 broad; tegmina exposed 2.0; caudal femora 24.3; antennae 51.5. Holotype deposited in the Tinkham Eremological Collection.

Female allotype: Same data as holotype. Caliper measurements in mm: body length 24.9; body length to apex of ovipositor 39.2; ovipositor 16.0 x 1.6 in middle; pronotum 7.7 x 7.7; antennae 51.6; caudal femora 24.9 x 5.2. Allotype in the Tinkham Eremological Collection.

Male paratypes: Twelve males same data as holotype; 2, 25-IV-1960. Range in calipered measurements (mm): body length 21.6-28.2; pronotum 7.2-8.1 (length) x 7.2-7.2 (breadth); caudal femora 23.1-24.0. Paratypes identical to the holotype male in every respect including coloration.

Female paratypes: Twelve females same data as allotype. Range in calipered measurements (mm): body length 23.6-27.6; total body length to apex of ovipositor 38.5-42.0; pronotum 8.2-8.8 x 7.2-7.8 (breadth); caudal femora 24.1-26.0; ovipositor 15.7 x 15.7.

Paired paratypes will be presented to such major orthopterological museums as the following: Academy of Natural Sciences of Philadelphia, British Museum, California Academy of Sciences, University of Michigan Museum of Zoology, Smithsonian Institution, and the Tinkham Eremological Collection.

Biology.— With the advent of the necessary winter rains in the Colorado Desert, it is believed that the nymphs hatch out either in the late fall or early winter. By late May the nymphs are in their last nymphal stadia and become adults in late June or very early July. The author has kept them alive in his home until late November, but whether they would survive the torrid heat of their rocky, inhospital habitat in the Gila Mountains is questionable.

Faunal Designation: *Platyoplus gilaensis* is a member of the Colorado Desert fauna, since the Gila Mountains represent the eastern periphery of that desert. The area ranging from just east of the Gila Mountains and extending 100 miles to Gila Bend is Gila Desert. Both are eremological components of the Great Sonoran Desert, which is composed of seven different deserts. At or in the region of Gila Bend, the Gila Desert merges with the Sahuaro Desert.

Floral Characteristics: In addition to *Larrea divaricata*, and *Franseria dumosa* growing sparsely on boulder-strewn slopes, *Bursera microphylla* is here more commonly represented than in any other desert sierra in the United States. Occasional *Cercidium microphyllum* and *Hyptis emoryi*, *Hoffmanseggia microphylla*, *Franseria ilicifolia*, *Ditaxis lanceolata*, *Eneclia farinosa*, and rarely *Carnegiea gigantea* are all characteristic of these barren, but very interesting, mountains.

Orthopteran associates: The orthopteran fauna is naturally quite impoverished, even in good years when up to three inches of rain may fall. However, since drought years have prevailed for the past decade, it is likely that some of the members present in the early forties are now extinct. Thus, *Tanaocerus* reported as *koebelei* in 1947 has not been seen since 1942. Likewise, *Oedomerus corallipes*, discovered in 1942 and reported for the first time in the United States in 1947, may also be close to extinction. Other orthopterans taken in the forties, including *Arphia aberrans*, *Tytthotyle maculata* the Malpais Lubber, and even *Trimerotropis p. pallidipennis*, have not been seen since 1949. Two other orthopterans are known from the Gila Mountains, namely, *Schistocerca vaga* and *Capnobotes fuliginosus*, both considered very rare.

Host Plants: *Platyoplus gilaensis* was first discovered hiding in a crevice of a giant boulder by day, in 1958, and it was not until 1960 that the first specimens were taken by night collecting. The subadult nymphs were found feeding in creosote bushes, about the only plant available in that habitat. On another occasion, also on creosote, a fine colony was found in a small mountain canyon. As far as is known, creosote is the host plant in nature.

Song: The stridulated note of *Platyoplus* is a soft "zee-zee-zee," long continued but scarcely audible beyond ten feet. The very large

tympanum characteristic of *Platyoplus* may be necessary in order to hear the feebly stridulated song.

Specimen preservation. Considerable has been written about the preservation of desert decticids, which are admittedly hard to preserve while maintaining colors that are close to those existing in the living creature. The usually large bodies filled with body fluids and the delicate coloration make good preservation difficult. The secret to fine preservation of body and color is the immediate gutting of the specimen upon its death. The decticids are collected alive in the field in specially designed cages, which the author has designed for the occasion. In this particular case, the large series of subadults was collected in the mountains in late May and removed to the author's home for proper study. Many biological notes were taken while the subadult specimens were developing into adults. In August, when the adults had been imagos for a month and all tissues were well hardened, small series at a time were killed with potassium cyanide. Each specimen killed was then immediately gutted by removing the alimentary tract and the gonads through a snip centrally or laterally on the three or four basal abdominal sternites. A little careful swabbing should be done to remove excess liquid, but care should be taken not to damage or disturb the subcutaneous color structure. A small fluff of cotton can then be inserted through the incision, although this is not necessary. If cotton is used, care should be taken that it not be rolled, because if a roll of cotton were pushed into the thoracic cavity, insertion of the insect pin could cause the whole to be pushed through the thoracic sternites, to the ruination of the specimen.

The specimens are now ready to be pinned, with legs and antennae arranged with the use of additional pins, on a sheet of balsa or white plastic cellulose. When the legs have been positioned by the pins and the antennae pulled back and positioned so that they lie along the dorsolateral line of the body, the creatures are ready for drying.

The pinning block is now placed in a gas or electric range. If gas, the oven should be only at pilot heat; that is, no burners on and the temperature no more than 125 F. Here they are watched and removed after several hours when dry. Care must be taken not to use more than gentle heat, since color injury can result. After several hours the specimens should be dry and the coloration in life almost perfectly preserved. Living color notes should be made of the freshly killed creatures.

One other method, relatively new, is also available. This is the freeze-dry method, where the creature is frozen immediately upon killing or death and left frozen for a long period of time, during which time it is completely desiccated by the cryoprocess. If this method is used, it may be necessary to relax the specimen or specimens overnight unless the specimens were pinned and legs arranged for the cryoprocess, which all depends upon the space available in the freezer.

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AN UNUSUAL POPULATION OF SPIDERS IN UTAH

Dorald M. Allred[1]

An unusual population of spiders belonging to the species *Neoscona oaxacensis* (Keyserling) was observed on West Mountain in Utah County, Utah, by Miss Mary Fenley and her mother, Mrs. Ed. J. Fenley, of Provo, Utah, while on a Labor Day outing in 1971. They kindly directed my attention to the phenomenon.

West Mountain is situated in a north-south axis along the southeastern side of Utah Lake. Its three major peaks have elevations of 6083, 6813, and 6904 feet, respectively. The level of the lake is at approximately 4487 ft. The predominant vegetation consists of various grasses along the foothill areas, and sagebrush and rabbit brush merging with a scattering of juniper trees at the higher elevations.

The spiders were densely distributed over several acres in the sagebrush and rabbit brush about midway up the mountain on the northern slopes. Only adults were present, and the females were predominant in number. The webs were not ornate as is typical of some of the other species of orb weavers. The radii of the webs were almost exclusively situated in some part of the individual shrub rather than in the spaces between shrubs. However, bridge lines frequently extended between separate plants. The bridge lines were of unusual strength, causing the limbs of plants to which they were attached to bend toward one another. As I walked between the plants and consequently broke the bridge lines, the tension of each line against my legs was almost like that of a lightweight twine.

Several random counts were made of the unusually high population of spiders. These varied from 10 to as many as 60 individuals per square meter. In more than 20 years of extensive field investigations in temperate desert areas I have never observed such a high, localized population of spiders of any species. Some of my colleagues stated that they had noted that populations of spiders of other species in Utah were much higher this year than they had ever seen previously; but they had not observed such a density as reported here. Dr. Willis J. Gertsch, who kindly identified the spiders and provided some information on their biology, indicated that many years ago the same species occurred in great numbers on the old Saltair Pavilion on the shore of Great Salt Lake west of Salt Lake City. Incidentally, Ralph V. Chamberlin at that time named the species *Neoscona saleria*, now a synonym.

According to Dr. Gertsch, *Neoscona oaxacensis* is a common orb weaver of the southwestern United States, ranging southward through Mexico to Panama. The species has had several names, probably the most familiar of which is *N. vertebrata* McCook, based on specimens from California. *Neoscona oaxacensis* is probably the

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largest of the species of the "smaller" round-shouldered araneas with elongate oval abdomens.

It is a species that often lives in clusters, with males, females, and the young stages living close together in webs. However, they are not necessarily tied by social habits, and their webs are single and not communal ones.

Continued annual observations of this species on West Mountain in order to determine cyclical population fluctuations related to environmental influences would be desirable.

SOME HELMINTHS FROM MINK IN SOUTHWESTERN MONTANA, WITH A CHECKLIST OF THEIR INTERNAL PARASITES

Delbert L. Barber[1,2] and Lawrence L. Lockard[2]

Abstract.— Thirty-four percent of 100 mink examined from Gallatin and Madison counties, Montana, revealed the presence of *Perostrongylus pridhami* Anderson, 1962 (Anderson, 1963), in the lungs. This is the first report of *P. pridhami* in the United States. Thirteen percent of the mink were infected with *Taenia mustelae* Gmelin, 1790. This is the first report of *T. mustelae* in southwestern Montana. A checklist of internal parasites of *Mustela vison* is included.

Parasites of mink in North America have been reported by numerous authors. No previous parasite surveys have been conducted on *Mustela vison* in southwestern Montana. The mink necropsied in this study were trapped in the Madison River, upper Gallatin River, and headwaters region of the Missouri River drainages during the winters of 1969 and 1970.

A total of 100 mink were examined. These animals were eviscerated and the viscera were placed in plastic bags and frozen. An NaCl fecal flotation was prepared to determine the presence of cestode and nematode eggs or larvae prior to examination of the animals. The gastrointestinal tract was dissected using an enterotome device (Figure 1). The contents were washed onto a 200-mesh screen,

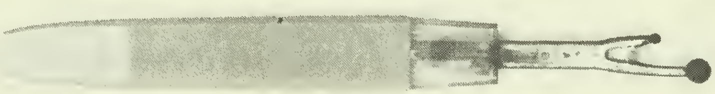

Fig. 1. Enterotome Device. Seam ripper modified with plastic bead placed on end of point to facilitate intestinal incisions.

then transferred to an illuminated tray for examination (Figure 2). Cestodes were fixed in 10 percent formalin, stained in Delafield's hematoxylin, dehydrated in ethanol, cleared in beechwood creosote, and mounted in HSR (Hartman-Leddon Co.). Lungs, liver, and kidneys were dissected and each was placed in a jar with water and agitated on a mechanical shaker for 20 minutes. The contents were poured onto a 200-mesh screen, washed, transferred to an illuminated tray, and examined. Lung tissues that appeared to contain cysts or capsules were pressed between glass plates and observed under a dissecting microscope. Adult nematodes removed from lung parenchyma were fixed in 70 percent alcohol-5 percent glycerol and mounted in glycerol. Skulls, when available, were examined for nasal nematodes.

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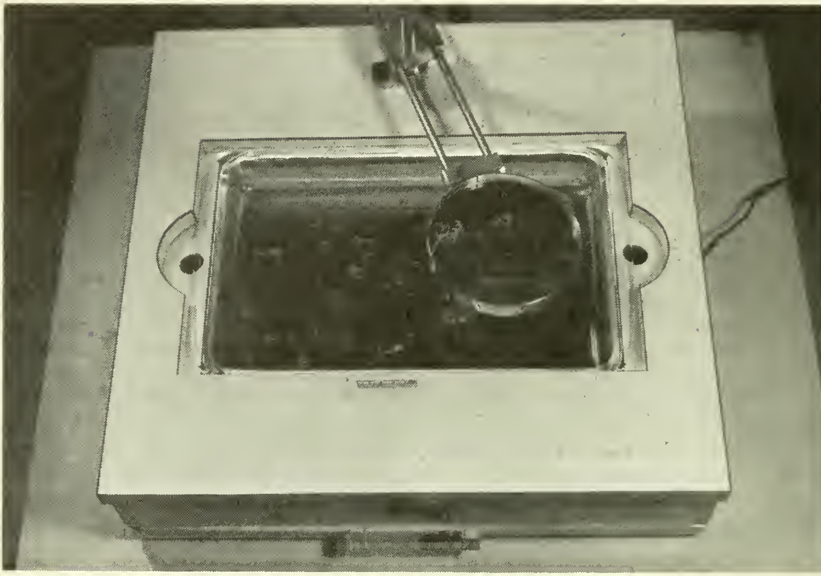

Fig. 2. Illuminated tray used in postmortem recovery of helminth parasites.

Results and Discussion

Fecal examinations revealed that 34 percent of 100 mink were passing first-stage nematode larvae. Three male nematodes and portions of two females were dissected out of the lung tissue; larvae were removed from the gravid females. These larvae were compared with those found in the fecal samples and it was determined that they were of the same type. The adult males were identified as

Table 1. Checklist of parasites reported from mink.

Parasite	Bibliography number
	Trematoda (Flukes)
Alaria freundi	85
A. minuta	18
A. mustelae	14, 15, 30, 31, 61
Apophallus muehlingi	86
Baschkirovitrema incrassatum	61
Cephalophallus obscurus	53
Cryptocotyle concava	57
C. lingua	57, 58
Enhydridiplostomum alarioides	61
Euparyphium beaveri	61
E. inerme	1, 51, 69, 90
E. melis	11, 30, 31, 38, 39, 46, 51
Euryhelmis monorchis	4, 30, 31, 61
E. pacificus	61, 80
E. pyriformis	61
E. squamula	38, 54, 61
Fasciola hepatica	58

Table 1 (continued)

Fibricola cratera	73
Metagonimoides oregonensis	47, 61, 81
Metorchis conjunctus	30, 31, 35
Nanophyetus salmincola	10, 38, 46, 78
Neodiplostomum lucidum	73
Paragonimus kellicotti	2, 3, 12, 30, 31, 35, 38, 49, 61, 79, 93
P. westermani	37
Parametorchis canadensis	38
Procyotrema marsupiformis	61
Sellacotyle mustelae	30, 31, 61, 94
S. vitellosa	61, 84
Tocotrema lingua	86
Troglotrema acutum	38
Cestoda (Tapeworms)	
Diplogonoporus tetrapterus	71
Mesocestoides litteratus	30, 31
Moniezia sp.	58
Taenia mustelae (=*tenuicollis*)	5, 29, 30, 31, 32, 33, 44, 45, 52, 59, 61, 66, 70, 72, 77, 83, 92
Acanthocephala	
Centrorhynchus conspectus	61
Corynosoma hadweni	58
C. semerme	28, 67
C. strumosum	28, 58, 67
C. sp.	9
Macracanthorhynchus ingens	17, 61
Protozoa	
Eimeria mustelae	43
Isospora bigemina	79
Nematoda (Roundworms)	
Aelurostrongylus falciformis	6, 8
Ascaris sp.	1, 35, 51, 61, 90
Capillaria mustelorum	30, 31, 35, 58, 61, 68, 79
Crenosoma hermani	6, 26
Dictyocaulus filaria	58
Dioctophyme renale	1, 12, 21, 24, 30, 31, 35, 36, 40, 50, 55, 56, 60, 61, 75, 76, 79, 95, 96, 97, 98
Dranunculus insignis	19, 22, 35, 42
D. medinensis	13, 20, 30, 31, 62
Epomidiostomum sp.	61
Eustrongylus gigas	38
Filaroides bronchialis	34, 79
F. mustelarum (=*martis*)	1, 6, 25, 30, 31, 40, 48, 61, 88, 89
Gnathostoma spinigerum	17, 38, 40, 99
Heterakis isolonche	61
Molineus patens	30, 31, 46, 61, 64, 82
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Muellerius capillaris	58
Perostrongylus pridhami (=*Aelurostrongylus*)	6, 7, 8, 87, 88
Physaloptera sp.	30, 31, 63, 65
Seurocyrnea sp.	61
Skrjabingylus nasicola	34, 41, 79, 91
Soboliphyme baturini	46
Strongyloides sp.	1, 51, 58, 90
Trichinella spiralis	16, 23, 27, 35, 40, 100

Perostrongylus pridhami Anderson, 1962 (Anderson, 1963), by Dr. Roy C. Anderson (personal correspondence). This parasite was previously reported by Anderson (1962) in Ontario, Canada. To our knowledge this is the first report of this species in the United States.

Thirteen percent of the *M. vison* were infected with the cestode *Taenia mustelae* Gmelin, 1790. Identification of these specimens was confirmed by Dr. Gerald D. Schmidt (personal correspondence). This is the first report of adult *T. mustelae* in mink from *Gallatin* and Madison counties in southwestern Montana.

Acknowledgments

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THREE NEW SPECIES OF *PALMOXYLON* FROM THE EOCENE GREEN RIVER FORMATION, WYOMING

William D. Tidwell,[1] David A. Medlyn,[1] and Gregory F. Thayn[1]

ABSTRACT.— Silicified, upright axes of *Palmoxylon* are abundant in the Green River Formation in Eden Valley, Wyoming. Three new species of *Palmoxylon*, as well as the previously described *Palmoxylon macginitiei* Tidwell et al., were collected. These new species are *P. edenense*, *P. contortum*, and *P. colei*. They are compared to *P. macginitiei* and other anatomically similar *Palmoxylon* species. *Palmoxylon edenense* appears to be the most abundant species at this locality.

Silicified remains of palm axes are very abundant in the Green River Formation in Eden Valley, Wyoming, near the collection site of *Palmoxylon macginitiei* (Tidwell et al., 1971). For the most part, these remains consist of axes in growth position surrounded by tough, silicified *Chlorellopsis* algae. However, one axis (*P. colei*) was collected lying down, as though it had fallen prior to fossilization. Weathered fragments eroded from these axes are found on the ground surface throughout the area.

The upright specimens occur in groups of threes and are arranged in either a triangular or linear alignment. Although the investigated specimens in these groupings were of the same species (either *P. macginitiei* or *P. edenense*), no rhizomous or soboliferous connections were uncovered between them.

With the exception of *Palmoxylon contortum*, the specimens vary from 6 to 12 inches in diameter and are generally 2 to 3 feet high. The incomplete horizontal stem of *P. colei* is nearly four feet in length. The preservation of the specimens is essentially the same as that discussed for *P. macginitiei* (Tidwell et al., 1971).

Palmoxylon edenense Tidwell, n. sp.

Figures 1, 2, 5A, 9

Stem

CENTRAL ZONE: This zone is characterized by the usual random arrangement of its vascular bundles. The bundles vary in size from 700 to 900 μ high by 500 to 600 μ wide. There are approximately 85 bundles per cm^2. The f/v ratio of these bundles is 3:1, although

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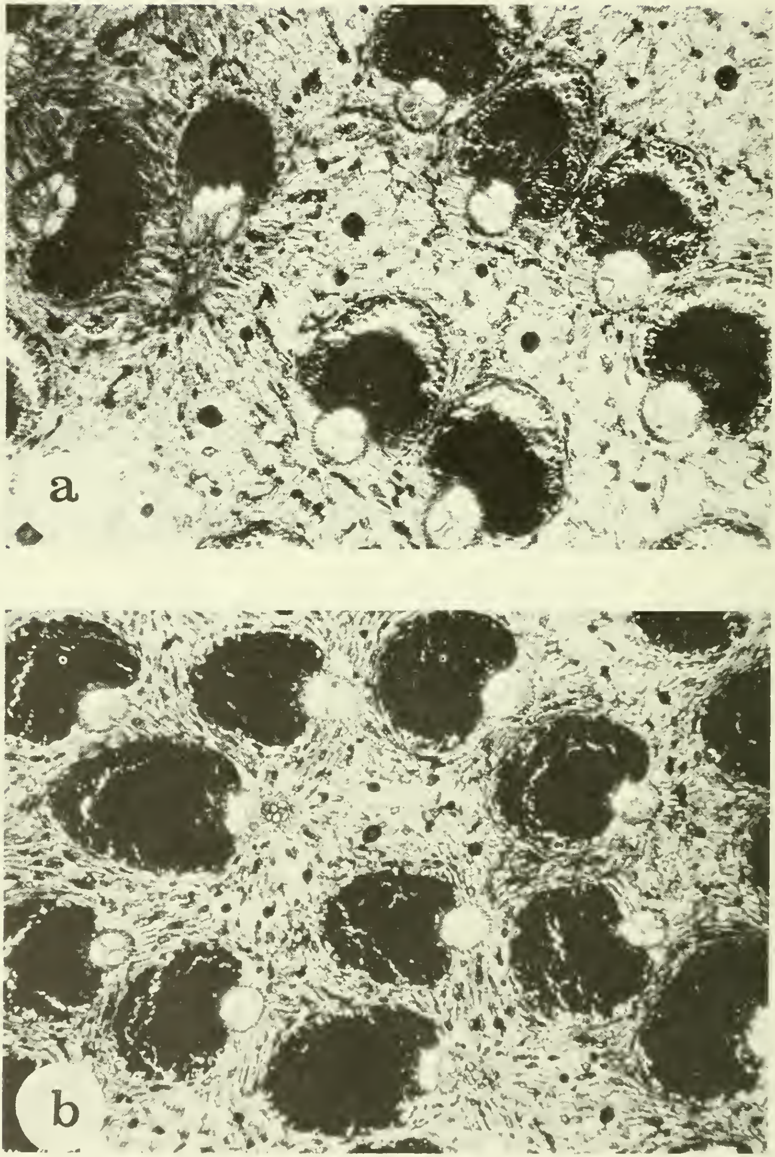

Fig. 1. *Palmoxylon edenense.* Cross-sections illustrating bundles of the (A) subdermal and (B) dermal zones (30X each).

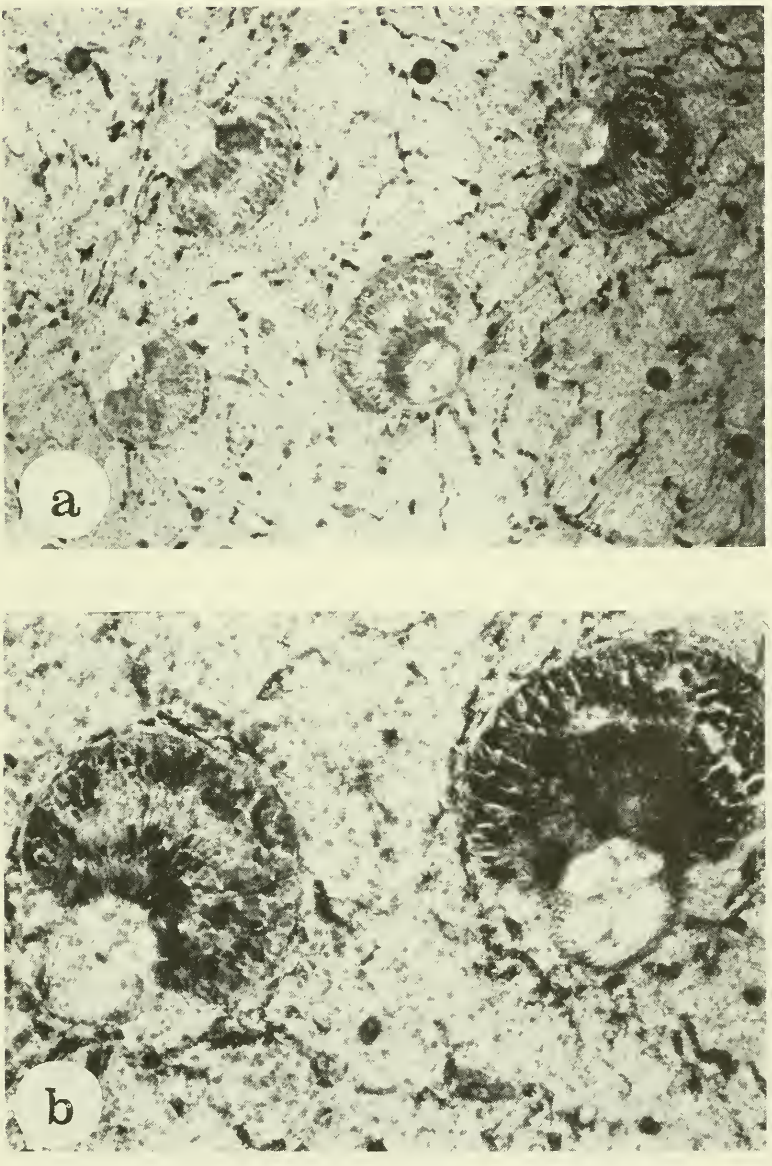

Fig. 2. *Palmoxylon edenense*. A. Cross-section of the central zone (30X). B. Enlarged bundles of the central zone (60X).

this may vary slightly (3.5:1.0). The fibrous bundle cap is oval to flabellate, having a shallow median sinus with rounded auricular lobes. Auricular sinuses are shallow to absent (Figure 2B). The cap is encased by one or two layers of tabular parenchyma, whereas radial parenchyma surrounds the vascular tissue. The bundles are typically bivascular, with metaxylem elements 78 to 91 μ in diameter and protoxylem elements varying from 25 to 35 μ. The phloem is not structurally preserved. The ground tissue is tightly compacted, consisting of elongated parenchyma cells. Numerous fibrous bundles, 350 per cm^2, varying in diameter from 52 to 104 μ are present but lack stegmata.

Subdermal Zone: Bundles of this zone tend to be irregularly oriented near the central zone and more or less regularly aligned close to the dermal zone. These bundles are similar in overall shape to those of the central zone, although their bundle caps are larger. The f/v ratio of the bundles is 5:1. There are approximately 100 bundles per cm^2 ranging in size from 600 to 700 μ high to 400 to 500 μ wide. The reniform bundle cap is usually as high as it is wide. The bundles are bivascular, and the size and shape of their vessel elements is similar to those of the central zone.

Cortical and Dermal Zone: The bundles are all regularly oriented with their caps towards the stem periphery. The bundles are more tightly compacted than are those of the subdermal zone, although they are not contiguous. There are approximately 205 bundles per cm^2. Their fibrous bundle caps tend to be radially elongated. The bundle f/v ratio of this zone is 7:1. The bundles, which are 600 to 800 μ high by 280 to 470 μ wide, are smaller than those in the other zones. As in the other zones, the fibrous cap is surrounded by tabular parenchyma, and radial parenchyma ensheaths the vascular tissue. The xylem contains two metaxylem elements that average about 50 μ in diameter. The radial and tabular parenchyma composing the ground tissue is compact. Numerous fibrous bundles and leaf traces appear throughout his zone.

Repository.— Brigham Young University, 916 (Holotype)

Locality.— Eden Valley, Wyoming

Horizon.— Green River Formation

Age.— Eocene

Palmoxylon colei, Tidwell, n. sp.

Figures 3, 4, 5B

Stem

Central Zone: The vascular bundles of the central zone are irregularly oriented and loosely compacted. This zone has approximately 115 bundles per cm^2. The bundles range in size from 500 to 600 μ in both height and width. Their f/v ratios vary from 2.5:1 to 3:1. The bundle cap fits Stenzel's *Reniformia* group (Stenzel, 1904) by having rounded auricular lobes with shallow auricular sinuses. The median sinus is only slightly indented, giving the

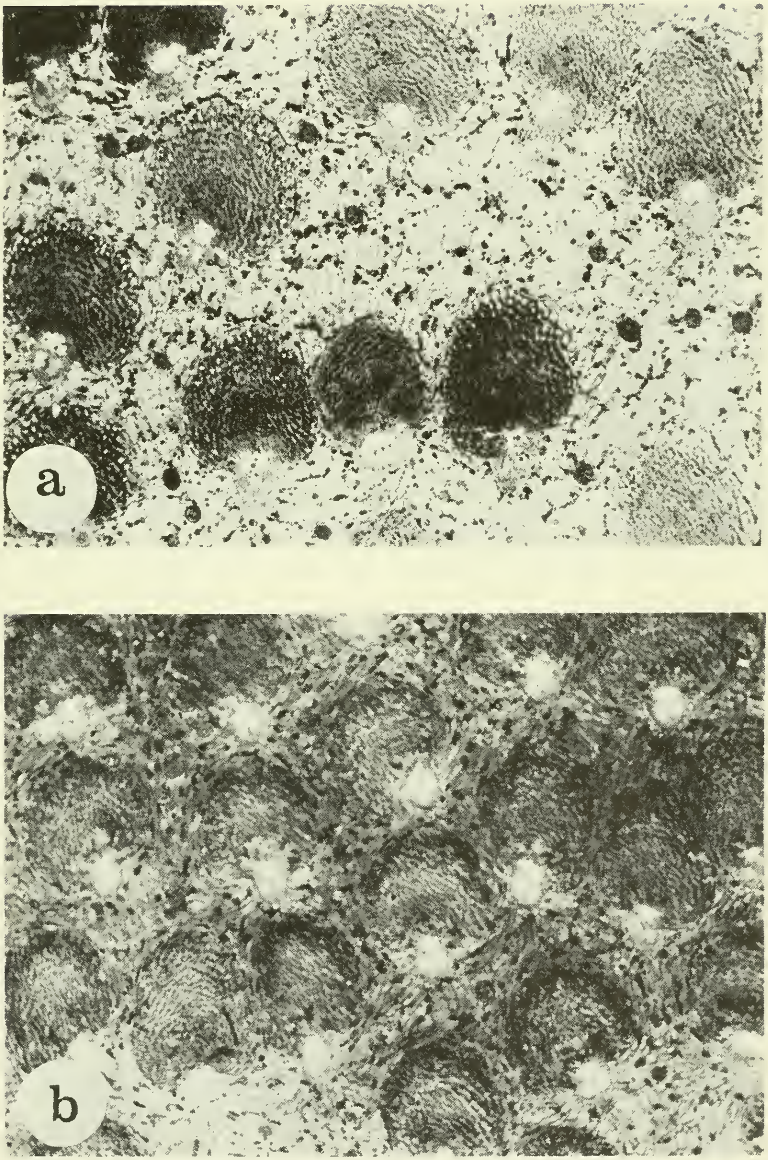

Fig. 3. *Palmoxylon colei.* Cross-sections of the (A) subdermal and (B) dermal zones (30X).

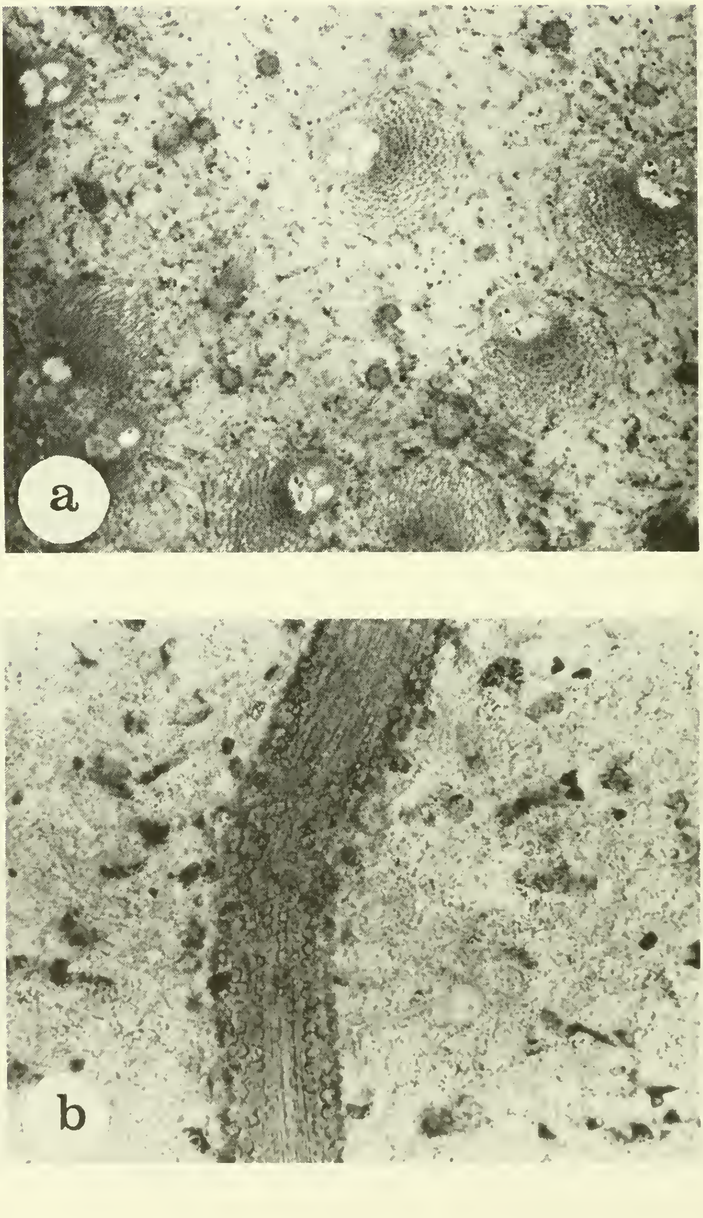

Fig. 4. *Palmoxylon colei.* A. Cross-section of the central zone (30X). B. Longitudinal section of a fibrous bundle demonstrating the stegmata along its surface (240X).

bundle cap its characteristic kidney shape (Figure 4A). The fibrous caps are encased by one or two layers of tabular parenchyma, but the vascular portion is encircled by radial parenchyma. The bundles are typically bivascular and the metaxylem elements are 65 to 85 μ at their widest diameters. The protoxylem, when present, varies from 30 to 40 μ in diameter. The phloem is not structurally preserved.

The ground tissue consists of thin-walled, tightly compacted, tabular and radial parenchyma, and has approximately 290 fiber bundles per cm^2. These bundles exhibit characteristic stegmata, and their diameters vary from 78 to 120 μ (Figure 5B).

Subdermal Zone: The bundles of this zone are irregularly aligned near the central zone and regularly aligned near the dermal zone. There are approximately 160 bundles per cm^2 in this region. The bundles are slightly larger than those of the central zone, being approximately 600 to 750 μ high and 500 to 650 μ wide. They have an f/v ratio of about 6:1, although this may vary slightly from bundle to bundle. The bundles are basically the same shape as those of the central zone, although the fibrous cap may approach a sagitate form in some. The presence of departing leaf traces that are attached to the vascular portion of several of the bundles is also notable. The bundles are commonly bivascular but may be trivascular. The metaxylem vessels are generally about 75 μ in diameter, although they vary from 65 to 85 μ. Fibrous bundles with their characteristic stegmata are present.

Cortical and Dermal Zone: The bundles of the cortical and dermal zone are tightly compacted, with approximately 230 bundles per cm^2. They are regularly aligned and have an f/v ratio of about 8:1. The bundle caps are reniform in shape but are elongated radially. The caps have rounded lobes and the auricular sinuses of the cap are shallow to nearly absent. The bundles are approximately 650 μ high and 400 μ wide. There are commonly two, occasionally three, metaxylem elements per bundle. Each element has an average diameter of 52 μ.

This specimen was named for its collector, Mr. Walter N. Cole, of Provo, Utah.

Repository.— Brigham Young University, 917 (Holotype)

Locality.— Eden Valley, Wyoming

Horizon.— Green River, Formation

Age.— Eocene

Palmoxylon contortum Tidwell, n. sp.

Figures 6, 7

Stem

The vascular bundles of all the zones are essentially the same size and shape, with the only observable difference being the degree of compaction. The number of bundles per cm^2 varies from 350 in the central zone to 500 in the dermal zone. They are tightly ap-

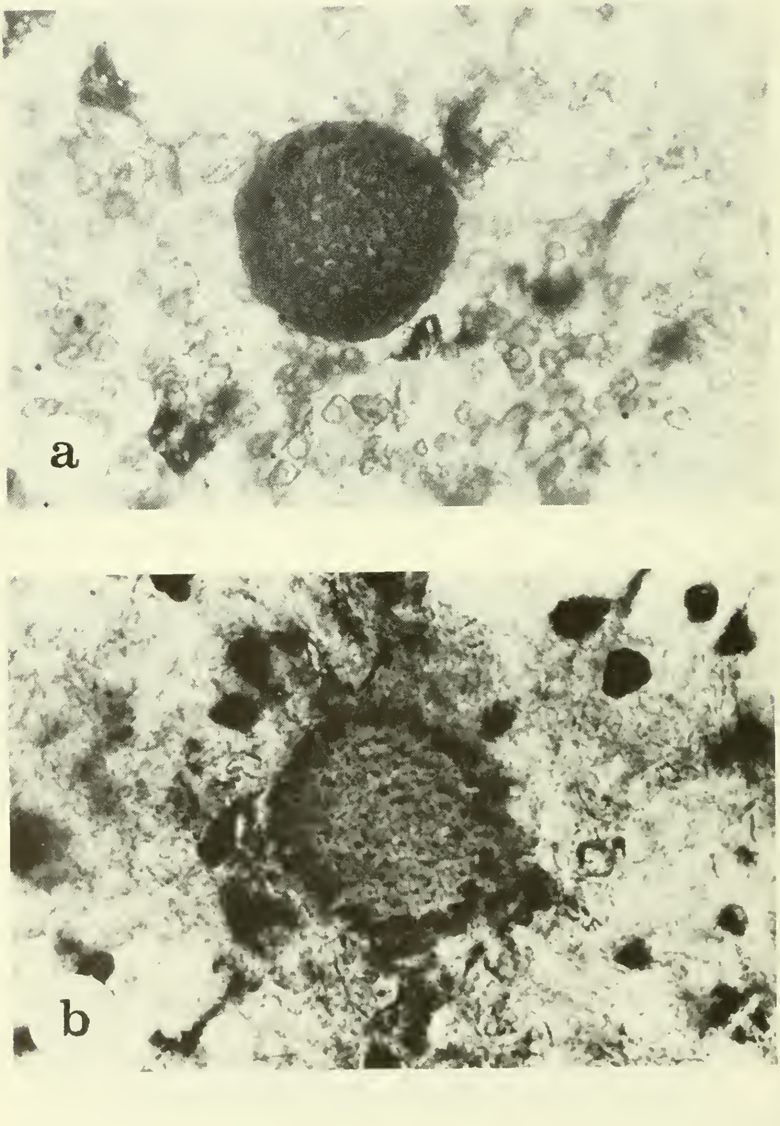

Fig. 5. A. Cross-section of a fibrous bundle of *Palmoxylon edenense*. B. A fibrous bundle of *P. colei* illustrating the stegmata surrounding the fibers. Both are 160X.

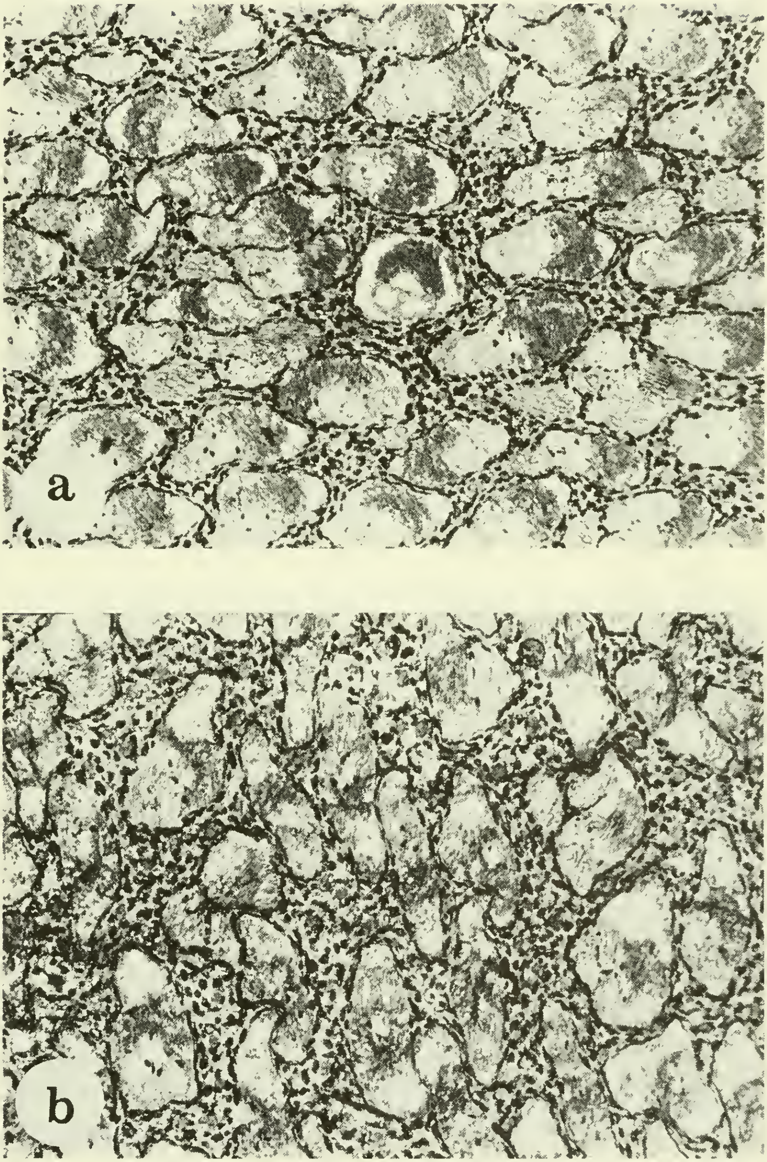

Fig. 6. *Palmoxylon contortum.* Cross-sections of the (A) dermal and (B) central zones showing the extreme closeness of the bundles causing their distortion (30X).

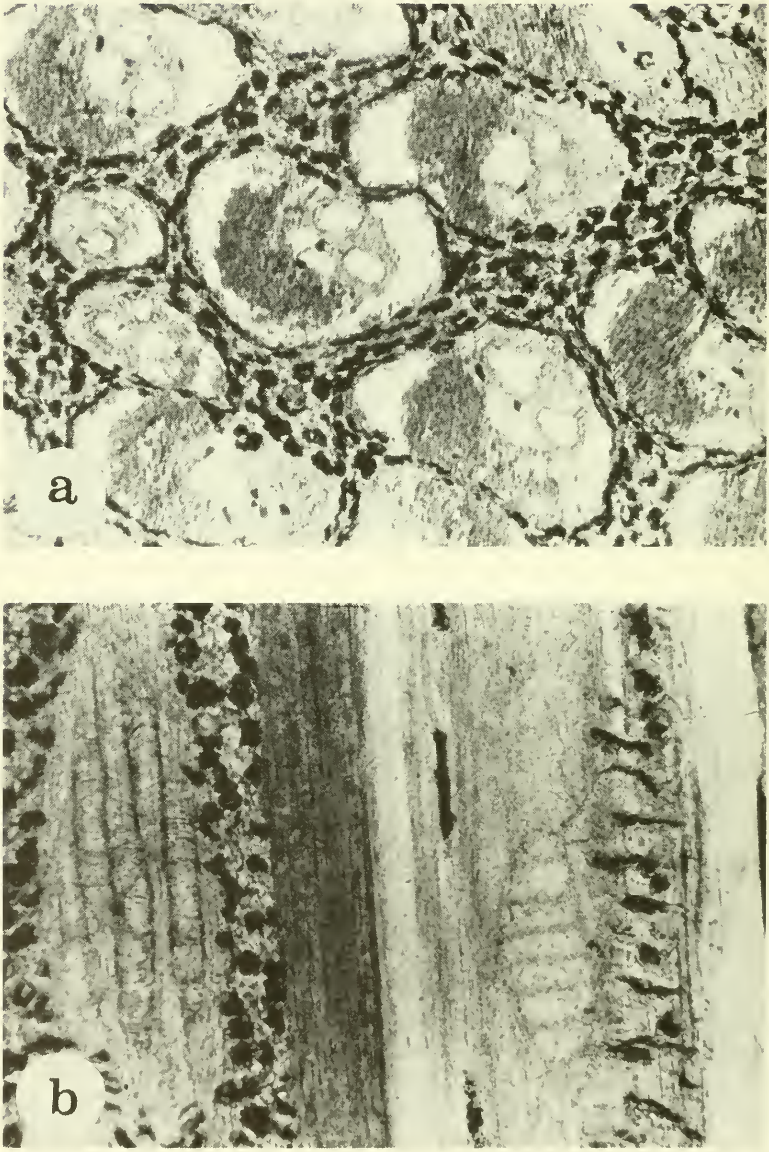

Fig. 7. *Palmoxylon contortum.* A. Cross-section of the dermal zone (30X). B. Longitudinal section of scalariform thickenings on some protoxylem vessels (240X).

pressed in all three zones but are distorted in the subdermal and dermal zones due to extreme bundle compaction. Where not compressed, the bundles are blocky to ovate in appearance. They typically lack auricular lobes and sinuses but have definite median sinuses. These bundles commonly contain more vascular than fibrous tissue, with an f/v ratio between 1:1 and 1:1.5. Both the vascular and fibrous cells are surrounded by tabular parenchyma. Bundle size varies from 320 to 400 μ high and 300 to 500 μ wide. The bundles are characteristically bivascular, with the large metaxylem elements averaging about 55 μ in diameter. The ground tissue is tightly compact, consisting mostly of thin-walled columnar parenchyma. Numerous sclerotic bundles ranging from 40 to 50 μ in diameter, without stegmata, are present. Specimens of this species were donated by Mrs. Marian Whitehead of Salt Lake City, Utah. They were approximately two inches in diameter.

Repository.— Brigham Young University, 918 (Holotype)

Locality.— Eden Valley, Wyoming

Horizon.— Green River Formation

Age.— Eocene

Comparisons

Palmoxylon macginitiei Tidwell et al. is similar in general anatomical features to both *P. edenense* and *P. colei*. *P. contortum* is dissimilar due to the disfiguration of the bundles and to the larger number of the vascular bundles per cm^2 and its overall size. All of these species have scalariform perforation plates on their metaxylem elements.

In order to delineate the above species, to give additional information, and to correct an error in the previous description of *Palmoxylon macginitiei*, a brief description of that species is included. *P. macginitiei* is characterized by the shape and size of its fibrovascular bundles (Figure 8A). They are oval, rarely rounded, and have a reniform bundle cap. The vascular portion of the bundle is blocky in appearance and is typically bivascular *with tyloses common* in the metaxylem elements (Figure 8B). The metaxylem vessels have scalariform perforation plates. The bundle size varies from 600 to 700 μ high by 450 to 500 μ wide in the central zone to approximately 420 μ high by 600 μ wide in the cortical and dermal zone. The number of bundles per cm^2 ranges from 104 in the central portion to 212 in the outer dermal zone.

Palmoxylon edenense, although similar to *P. macginitiei*, should be considered a separate species because of the difference in degree of bundle compaction and bundle shape. *P. edenense* has an fV ratio of 3:1 to 3.5:1 in the central zone, whereas the ratio for *P. macginitiei* is 1.5:1 to 2:1. Therefore, the bundle caps of *P. edenense* are larger than those for *P. macginitiei*. Hence, more definite auricular lobes and sinuses are present than in *P. macginitiei*, and the overall outline of the vascular portion is more rounded and not as blocky in appearance. The fibrovascular bundles of *P. edenense* are

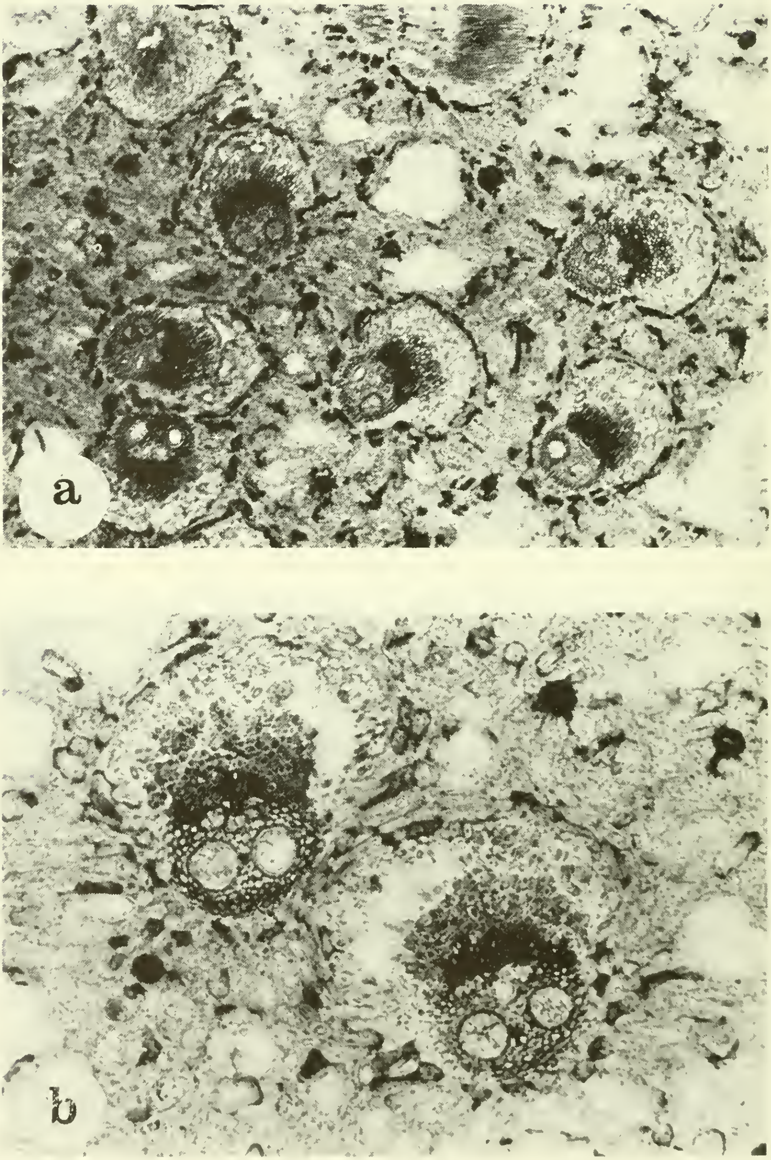

Fig. 8. *Palmoxylon macginitiei*. A. Cross-section of the central zone (30X). B. Enlarged cross-section of bundles showing tyloses in the vessels (60X).

less compacted, with 85 bundles per cm² in the central zone to 205 bundles per cm² in the cortical and dermal zone.

Palmoxylon colei is unique in that it possesses stegmata, an anatomical structure which sets it apart from *P. macginitiei.* It also differs from the latter in bundle shape, with less vascular tissue in the central zone. Also both *P. colei* and *P. edenense* characteristically lack tyloses in the metaxylem elements.

Palmoxylon edenense is similar to *P. macginitiei.* Therefore, the comparisons between *P. macginitiei* and other previously described *Palmoxylon* species (Tidwell et al., 1971) would also be valid for *P. edenense.* Although further study has shown that *P. crassipes* Unger is similar, it differs in that it has a complanate bundle cap and less vascular tissue in the central zone. The bundle cap of *P. edenense* tends to be less rounded and more flabellate with a deeper median sinus. *P. hungaricum* Greguss (Greguss, 1959) shows a close affinity to *P. edenense* but has larger and more widely spaced fibrovascular bundles.

The presence of stegmata (stegmata is an anatomical feature found only in fossil palms [Stenzel, 1904]) in *Palmoxylon colei* restricts the number of similar species for comparison. Stenzel (1904) described three species exhibiting stegmata: *P. densum*, *P. confertum*, and *P. astrocaryoides.* These all differ from *P. colei* in their characteristic bundle shape, with *P. densum* also having distinctly smaller bundles. Sahni (1964) described *P. pondicherriense*, a palm with stegmata from India. This species is dissimilar from *P. colei* in that the bundles in the latter are less numerous and that they have a reniform bundle cap instead of the lunarian form of *P. pondicherriense.*

Palmoxylon contortum is a unique fine-bundled palm, and only a few species of *Palmoxylon* are even similar. *P. liebigianum* Shenk, which Sahni regards as synonymous with *P. kvishna*, also exhibits compact bundles, 150 per cm² in the central zone to 250 per cm² in the dermal zone, although the fibrovascular bundles of *P. liebigianum* are not appressed and disfigured, and its vascular bundles have lunarian-shaped bundle caps rather than reniform. *P. ceylanicum* Unger was considered by Stenzel (1904) as a variety of *P. liebigianum.* However, Sahni (1964) concluded that *P. ceylanicum* should be maintained as a separate species. He based this on the vascular bundles of *P. ceylanicum* being thinner and more crowded than in *P. liebigianum. P. contortum* differs from the above by its distinctive bundle shape, its degree of compaction, and its characteristic bundle distortion.

Palmoxylon colei varies from *P. simperi* Tidwell, *P. pristina* Tidwell, and *P. gustavsoni* Tidwell et al. by having stegmata which the latter species lack; and *P. contortum* varies from them by its smaller size and by having more compressed, distorted bundles.

Discussion

In comparing *Palmoxylon edenense* and *P. macginitiei* with *P. simperi* Tidwell and *P. gustavsoni* Tidwell et al., it is a case of com-

paring species representing the basal portion of palm stems, or the so-called "stemless" varieties, from the Green River Formation with the distal portions of *P. simperi* and *P. gustavsoni.* Tomlinson and Zimmermann (1967) illustrated the different vessel types they had mascerated from a species of *Sabal.* The base of the stem had rather long vessels with scalariform perforation plates similar to the Eden Valley taxa; whereas those near the middle and top of the same axis had short vessels with simple pores like *P. simperi* and *P. gustavsoni. P. simperi* and *P. gustavsoni*, whose stem bases have not been observed, are from the same geographical area in central Utah (Tidwell et al., 1972). Scott et al. (1972) implied that all specimens from this area are of the same species; however, they most probably represent the middle to upper portions of *P. simperi* and *P. gustavsoni.* Thus, in comparing these latter two species to each other at about the same stem elevation and from the same zone (central), they are quite distinct and probably portray more than a delineation between form species.

As further discussed by Tomlinson and Zimmerman (1967), the apical portion of a palm stem is always softer than the basal part. Consequently, when dead, they generally rot from the apex to base. The anatomy of the upper portions of the stem of living palms is easily sectioned and thus studied, whereas the basal portions are most often fossilized. Therefore, the matching of the anatomy of fossil and living forms becomes a dubious procedure, and comparisons between the different parts of the stem may result in rather inaccurate conclusions. Therefore, comparisons between species representing the basal portion of the palm stems with those of the upper part would not be conclusive.

The specimens of *Palmoxylon macginitiei* and *P. edenense* appear to be complete palm axes. They do not indicate any truncation of the stems as would be anticipated if the stem had been originally taller (Figure 9). The bases of these specimens are surrounded with roots, whereas the middle and upper portions of these same axes have numerous attached petiole bases. The apices of these specimens consist of overlapping petiole bases. In progressing up the stem, each successive base becomes smaller and closer to the center of the axis.

These stems may represent either very young stems or the so-called "stemless" palms similar to *Nipa*, some species of *Acanthococos* and *Serenoa.* Several forms of Palmae do not have any trunks above ground and thus are similar to the specimens from Eden Valley. In *Serenoa repens*, leaves appear to come right out of the ground, whereas *Attalea cohune* grows for many years before its trunk shows and has been mistaken as trunkless (McCurrah, 1960). Living *Nipa* palms balance enormous stemless rosettes on the treacherous semiliquid mud of estuaries by means of a stout horizontal trunk (Corner, 1966). These spread by means of branching rootstocks. In the Philippine Islands, a *Nipa* marsh has been reported covering approximately 20,000 acres (McCurrah, 1960).

The particularly numerous upright specimens from Eden Valley

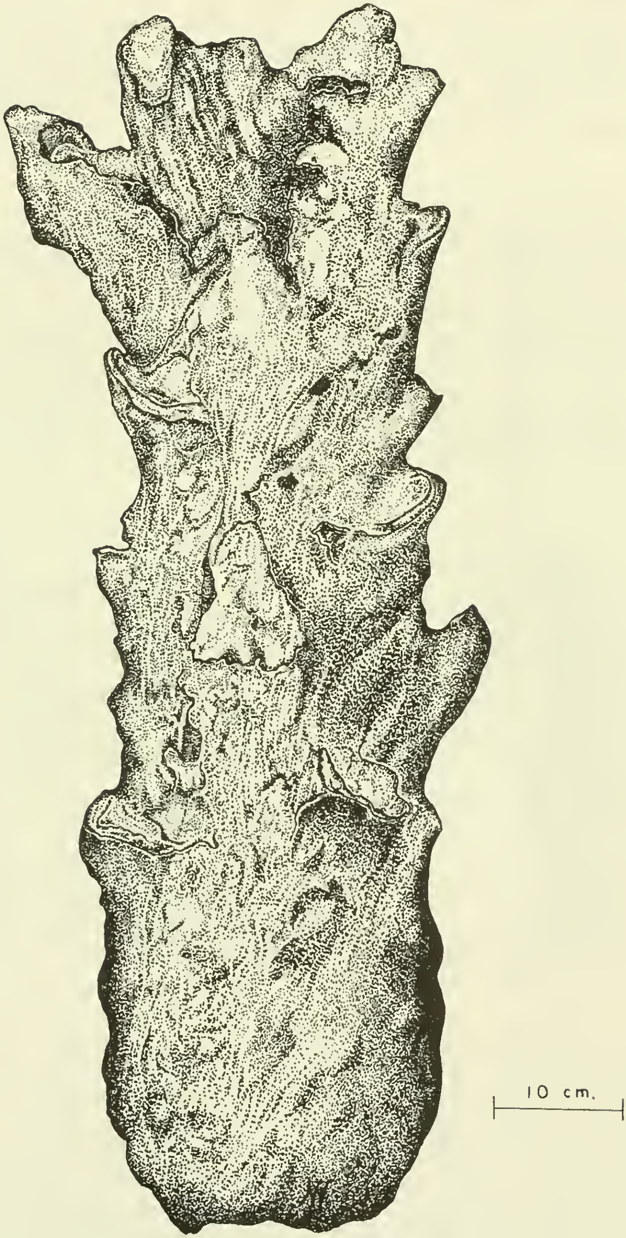

Fig. 9. A specimen of *Palmoxylon edenense* drawn after collecting. Note the attached petioles. Roots are present in the lower portion of the specimen.

appear to represent the stemless types rather than the younger forms of taller trunked species. With the number of specimens at this locality, it would seem that intermediate stages of the trunked forms would also be present and these have not been observed. However, it is anticipated that further collecting will provide additional information concerning these forms and their possible placement.

Acknowledgments

The authors wish to acknowledge the assistance of the following: Naomi Hebbert and Paul Smith for aiding in preparing the illustrations and collecting, Mrs. Marian Whitehead of Salt Lake City and A. Daniel Simper of the University of California at Davis for their help in collecting and thin-sectioning of the specimens, Mr. Walter Cole of Provo for donating a specimen of *Palmoxylon colei*, and Dr. J. Keith Rigby of the Department of Geology and Dr. S. R. Rushforth of the Department of Botany at Brigham Young University for reviewing the manuscript.

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ON THE TAXONOMIC STATUS OF PLATYPODIDAE AND SCOLYTIDAE (COLEOPTERA)

Stephen L. Wood[1]

Abstract.— The reduction of Platypodidae and Scolytidae to subfamilies of Curculionidae by certain recent authors is questioned. Several fundamentally important anatomical characters that could not possibly have been derived from Curculionidae are cited. Platypodidae (including Coptonotidae) is recognized provisionally as a derivative of Scolytidae; Scolytidae, with subfamilies Hylesininae and Scolytinae (including Ipinae), is also recognized as a family. *Protoplatypus*, new genus, for *P. vetulus*, n. sp., a primitive platypodid from New Guinea, and *Protohylastes*, new genus, for *Pr. annosus*, n. sp., a primitive scolytid from Queensland, are described.

Apparently commencing in 1954 with Crowson (1967:155), a number of coleopterists have reduced the traditionally recognized families Scolytidae and Platypodidae to the rank of subfamily within the Curculionidae without establishing a foundation for this action. The recent generic classification of the Platypodidae (Schedl, 1972) neglected either to acknowledge or to respond to this change.

In reviewing more than a dozen classifications of higher categories within the Curculionoidea, the most striking feature noted in them is the lack of agreement on even the most fundamental divisions of the group, apparently due to a lack of detailed knowledge on the morphology of this enormous superfamily. It would appear that only Crowson's (1967) major division, based on separate or confluent gular sutures, is the only phylogenetically sound division of the group that has been presented. His classification of families in the first division (couplets 1 to 5) is reasonable (although the Oxycorynidae and Proterhinidae are unknown to me). His classification of the second division, groups having only one median gular suture (couplets 6 to 8), is questioned. The basis for this question is an unpublished and incomplete comparative anatomical study of the Curculionoidea that was started many years ago but interrupted due to the lack of specimens for dissection in critical groups. The following comments relating to the pregula and pregular sutures were drawn from that study.

In the superfamily Curculionoidea five families (Crowson, 1967) have at least the posterior indications of widely separated gular sutures. In the Belidae these sutures continue separately to near the ventral apex of the rostrum, where they diverge and direct their course to or at least toward the anterior tentorial pits above the anterior articulation of the mandible as in other insects. In the Anthribidae these sutures are obsolete except for minute irregularities on the margin of the occipital foramen; in Nemonychidae and apparently in Oxycorynidae (not seen) and Proterhinidae (not seen), separate sutures (Crowson, 1967: Figures 201-202) extend anteriorly

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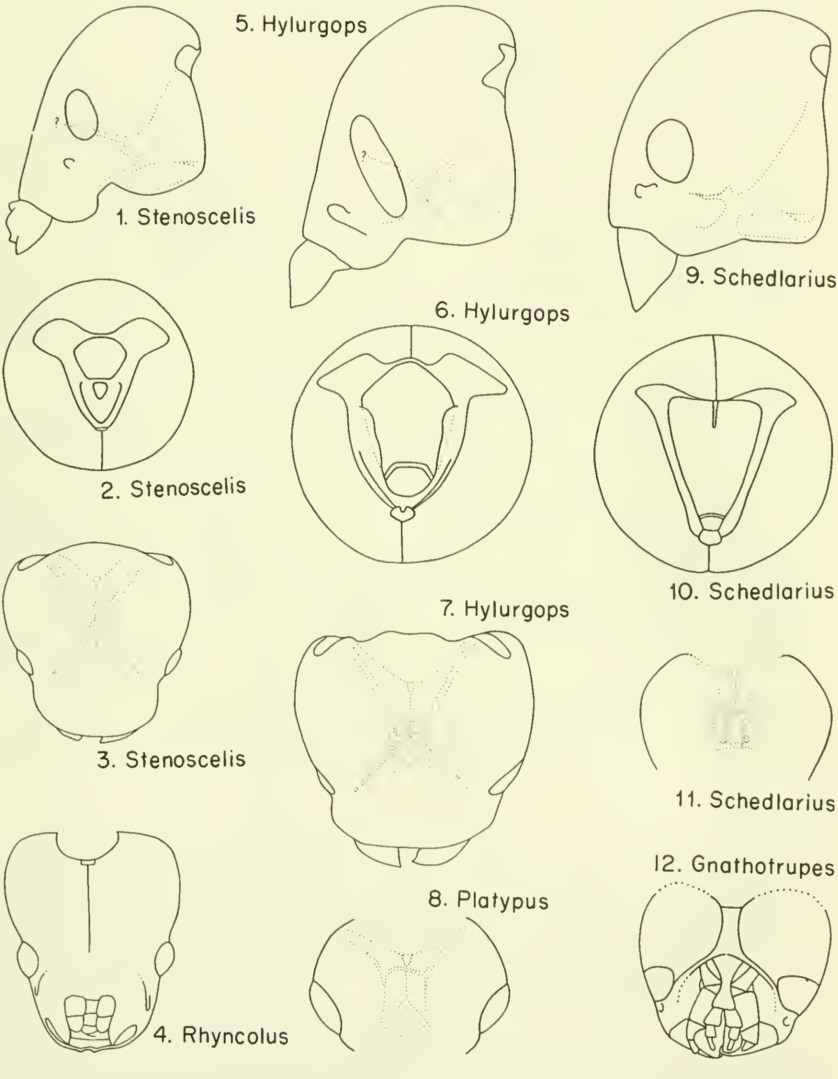
to the posterior tentorial pits. In all other Curculionoidea the gular sutures are confluent, with only one median suture (usually) visible from near the occipital foramen to the single, median, posterior tentorial pit at the ventral base of the rostrum. Apparently all workers have overlooked the minute postgula on the margin of the occipital foramen at the base of the gular suture (Figures 1-19). Some workers, realizing that a pregula should be present (c.f. Hopkins, 1909:16, and Stickney, 1923), either created pregular sutures for their illustrations of curculionids or misinterpreted longitudinal ridges on the rostrum as being pregular sutures. In a survey of several hundred genera of Attelabidae, Brenthidae, Apionidae, and Curculionidae (s. str.) I was unable to find any representative having pregular sutures accompanied by internal ridges that resulted from the inflection of the cuticle to form those sutures. However, pregular sutures are conspicuously present in all Platypodidae and in all Scolytidae except a few Micracini, etc., that bore into exceedingly hard wood (in which case the gular suture is also obliterated).

It apparently has been traditional among those coleopterists who have considered the matter (Crowson, 1967:155; Schedl, 1972) to presume that the Scolytidae were derived from the tribe Rhyncolini of the subfamily Cossoninae and that the rostrum of the ancestral form was lost when scolytid habits were established. Yet in no truly primitive platypodid or scolytid is there a rostrum resembling that of Cossoninae. Furthermore, no representative of the Rhyncolini or of any other cossonid known to me (including an apparently unnamed Australian cossonid genus with absolutely no rostrum whatever and large mandibles) has pregular sutures (Figure 4). In this latter character I have found no intergradation, either externally or in the much more complex internal structure. The recognition of this fact suggests that other indicators of phyletic relationship be examined.

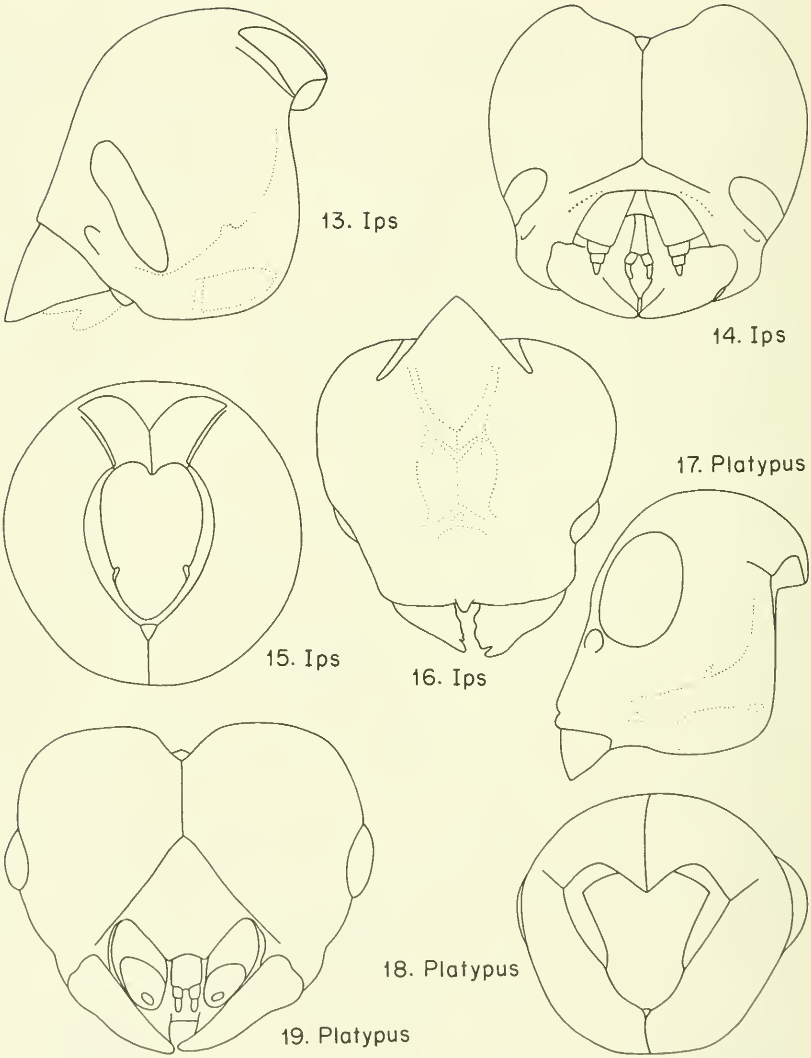
Primitive Platypodidae, primitive representatives of all primitive tribes of Scolytidae, and many Cossonini have interstriae 10 on the elytra broad throughout its length to near the elytral apex. In all Rhyncolini known to me the portion of interstriae 10 posterior to the level of the hind coxa is strongly constricted or entirely obsolete. Therefore, based on this character in living material examined, there is no possibility that the Rhyncolini could have given rise to either the Platypodidae or Scolytidae.

Crowson (1967:158) indicated that all adult Curculionoidea having one gular suture, except Attelabidae, have the adult maxillary palpus 2- or 3-segmented. Browne (1971:49) reported a 4-segmented maxillary palpus in *Austroplatypus* Browne, a platypodid. It is very doubtful that this genus was derived from an ancestral form having a 3-segmented maxillary palpus.

In all Rhyncolini and most (all?) Cossoninae known to me there is a conspicuous spine on the margin of the oral fossa that arises between the posterior margin of the mandible and the base of the maxilla (Figure 4). There is no comparable structure or irregularity in this area in Platypodidae or Scolytidae (Figures 12, 14, 19).



Figs. 1-12. Head capsules of beetles with the tentorial appartus indicated by dotted lines: 1-3, *Stenoscelis brevis* (Boh.), Cossoninae, 1 lateral, 2 posterior, and 3 dorsal aspects; 4, *Rhyncolus knowltoni* (Thatcher), Cossoninae, ventral aspect; 5-7, *Hylurgops rugipennis* (Mannerheim), Hylesininae, 5 lateral, 6 posterior, and 7 dorsal aspects; 8, *Platypus lucasi* Chapuis, Platypodinae, dorsal aspect; 9-11, *Schedlarius mexicanus* (Dugès), Coptonotinae, 9 lateral, 10 posterior, and 11 dorsal aspects; 12, *Gnathotrupes* sp., *Scolytinae*, ventral aspect.



Figs. 13-19. Head capsules of beetles with the tentorial appartus indicated by dotted lines: 13-16, *Ips mexicanus* (Hopkins), Scolytinae, 13 lateral, 14 ventral, 15 posterior, and 16 dorsal aspects; 17-19, *Platypus lucasi* Chapuis, Platypodinae, 17 lateral, 18 posterior, and 19 ventral aspects.

Kuschel (1966:6) suggested that a series of spines on the lateral margins of the tibiae in Scolytidae and in the Araucariini (Cossoninae) indicate a relationship between these groups. Evidently it was not recognized that the most primitive genera of Scolytidae lack these spines and have tibiae more nearly like the Cossonini or even like certain Brenthidae. The supernumerary tibial spines in these

groups apparently were acquired independently as they adapted to a common niche and, therefore, are not primitive. Kuschel also called attention to the similarity in habits of the Araucariini and Scolytidae. In the two species of Araucariini (presumably *Coptococynus* spp.) examined in the field, the habits do not resemble in any way those of more than 2000 species (about 30 percent of the known fauna) of Scolytidae I have studied in the field. The habits of certain neotropical Rhyncolini (unidentified) are infinitely more similar to primitive scolytids.

Larval characters that separate the Scolytidae from Curculionidae have not been reported, presumably due to inadequate research rather than to the absence of characters. Most larval Platypodidae have the clypeus reduced or absent and the labrum somewhat enlarged. The cercus-like processes in *Trachyostus* (Browne, 1967: Figure 20) and the tenth abdominal segment of *Dolgopygus* (Browne, 1967: Figure 23) require investigation.

It is my contention that the Scolytidae and Platypodidae represent a phyletic line that diverged from other Curculionoidea before pregular sutures were lost and before a rostrum developed. The Cossoninae (Figures 1-4) are true curculionids in the structure of the gular area, tentorial apparatus, head, legs, and body form, and probably resemble scolytids largely because they independently occupied the same or a similar niche. While the scolytids and platypodids clearly fall within the Curculionoidea, it is as logical to recognize them as an independent group as it is any other family within this superfamily. There is great difficulty, however, in separating the Scolytidae from the Platypodidae, and I find it difficult to give independent family status to the latter group.

In order to emphasize the significance of the above items, it is necessary to describe the most primitive platypodid and the most primitive hylesinine scolytid known to me.

Protoplatypus, n. gen.

The phloeophagous habit and normal tarsi of this remarkably primitive genus suggest that it should be placed in the family Scolytidae; however, the head, tibiae, pronotum, and other characters indicate a closer relationship to primitive Platypodidae. Although not closely related to either genus, its phylogenetic position probably lies between *Mecopelmus* Blackman (Platypodidae) and *Craniodycticus* Blandford (Scolytidae). For convenience of reference I tentatively place it in the Mecopelmini (Platypodidae).

Characters of particular significance in phylogeny found in this genus include the cylindrical, 3-segmented maxillary palpus, an antenna intermediate between that of *Platytarsulus* (Platypodidae) and *Craniodycticus* (Scolytidae), a protibia intermediate between that of *Schedlarius* (Platypodidae) and *Protohylastes* (Scolytidae), an eye similar to that of platypodids, and tarsi similar to those of scolytids. The phloeophagous and polygamous habits are, for the most part, typical of scolytids.

Description.— Head about as in *Schedlarius* Wood; eyes subcircular, moderately convex; pregula rather large, as in most Platypodidae; antennal scape long, slender, funicle 5-segmented, club rather small, somewhat flattened, entirely devoid of sutures, glabrous except for a marginal fringe of abundant, short hair (much as in *Platytarsulus* Schedl but much more restricted to actual margin). Pronotum elongate, sides constricted as in most Platypodidae; precoxal area of prosternum elongate, almost half as long as entire prosternum, precoxae small, very widely separated. Scutellum subacutely pointed behind. Elytral bases rounded, not precipitous, striate, interstriae 10 attaining declivital area; posterior area declivous, sculpture simple. Protibiae of platypodid type; tarsi with segment 1 only slightly longer than 2 or 3, very slightly shorter than 5, entire tarsus slightly longer than tibia, all segments cylindrical.

Type species.— *Protoplatypus vetulus* Wood, described below.

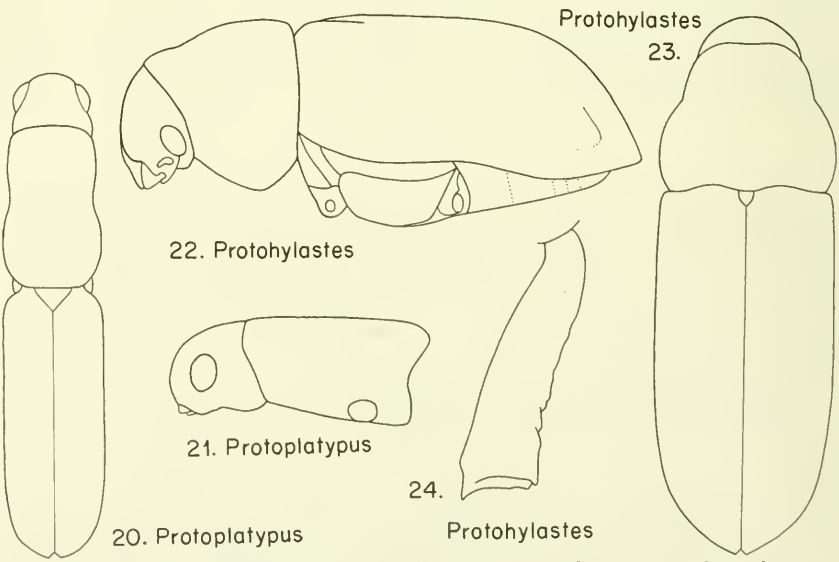
Protoplatypus vetulus, n. sp.

Figures 20, 21, 26

This species is distinguished from other known forms by characters summarized in the above description of the genus. It could be placed in either the Platypodidae or Scolytidae, depending upon which characters are emphasized.

Male.— Length 1.2 mm (paratypes 1.2-1.5 mm), 4.0 times as long as wide; color light brown.

Frons strongly, rather evenly arched from epistoma to vertex,



Figs. 20-21. *Protoplatypus vetulus* Wood: 20, dorsal aspect; 21, lateral aspect of head and prothorax, leg omitted. Figs. 22-24, *Protohylastes annosus* Wood: 22, lateral aspect; 23, dorsal aspect; 24, anterior aspect of left metathoracic tibia.

rather broadly convex, somewhat intermediate between *Schedlarius* and *Coptonotus* Chapuis; surface reticulate, with sparse, fine, shallow punctures; vestiture very sparse, hairlike; eye broadly oval to subcircular, moderately convex; pregula rather large, as in Platypodidae; maxillary palpi cylindrical, 3-segmented.

Pronotum 1.5 times as long as wide; widest on basal third, sides conspicuously constricted just in front of middle, anterior margin only slightly narrower than base; surface shining, reticulate at base and sides, longitudinally, subreticulately strigose on discal area, punctures minute, shallow, moderately close. Glabrous.

Elytra 2.3 times as long as wide, 1.6 times as long as pronotum; sides straight and parallel on basal three-fourths, broadly rounded behind; scutellum acute; elytral bases rather weakly, not precipitously, elevated; entire surface strongly reticulate; striae not impressed, punctures small, moderately deep, spaced within row by about two diameters of a puncture; interstriae twice as wide as striae, punctures very small, widely, regularly spaced. Declivity confined to posterior fourth, broadly convex; striae about as on disc; interstriae 1 and posterior half of 9 moderately, continuously elevated and meet at sutural apex, 3 less strongly elevated and ending before attaining 9. Vestiture of sparse, very minute, almost scalelike setae.

Female.— Similar to male except frons with a triangular area on lower two-thirds smooth, shining, its upper margins marked by an irregular row of small punctures; scape with setae near apex distinctly longer.

Type Locality.— Five miles or 8 km NW Bulolo, Morobe, New Guinea.

Type Material.— The male holotype, female allotype, and 96 paratypes were collected at the type locality in the LATEP logging area, on 9-VIII-72 from the bole of a recently cut *Harpullia pedicellaris*, by S. L. Wood. The parental galleries were in the cambium region but did not engrave the wood; they were of the radiate type, and the beetles appeared to be polygamous. Larval mines were parallel to the grain of wood and were visible on the inner surface of peeled bark.

The holotype, allotype, and several paratypes are in the Australian National Collection at Canberra; the other paratypes are in the British Museum (Natural History) and in my collection.

Protohylastes, n. gen.

This genus superficially resembles *Hylurgops* LeConte or *Pseudohylesinus* Swaine, except that the tibiae are completely different from any other genus of Hylesininae and the protibiae are more nearly like a curculionid (Curculionoinae) than a scolytid. The bases of the elytra are similar to those of *Hylurgops*, without a definite marginal row of crenulations, except that the submarginal crenulations are even more poorly developed.

DIAGNOSIS AND DESCRIPTION.— Head much as in *Pseudohylesinus;* eye oval, short; antennal scape short, funicle 7-segmented, shorter than scape, club as long as scape, small, subconical but distinctly flattened, entirely devoid of sutures. Prothorax about as in *Pseudohylesinus* except coxae rather widely separated, an acutely elevated ridge extending from anterolateral margin of coxa to anterolateral margin of prothorax (as in *Hylurgops*). Elytra much as in *Hylurgops* except basal margins not armed and interstriae 10 extends to declivity. Anterior tibia slender, entirely unarmed on margins, a terminal spine next to tarsal insertion at center of apex, a very small spine on lateral and median apical angles; meso- and metathoracic tibiae similar except obliquely truncate at apex, with a very short, blunt spine on both inner and outer angles (Figure 24). Tarsal segments 1 and 5 each about as long as 2 and 3 combined, 3 broadly bilobed.

TYPE-SPECIES.— *Protohylastes annosus* Wood, described below.

Protohylastes annosus, n. sp.
Figures 22-25

This species resembles a very large *Pseudohylesinus,* but it is distinguished from all previously known Scolytidae by the very different tibiae.

ADULT.— Sex not determined. Length 9.8 mm, 2.6 times as long as wide, color very dark brown, vestiture pale.

Frons convex, epistomal area transversely impressed, a small, median impression at upper level of eyes; surface smooth, shining, punctures moderately coarse, close, their interiors apparently reticulate; subglabrous, a few scales on lateral margins, a few hairlike setae in epistomal area. Eye oval, about 1.5 times as long as wide. Antenna as described above.

Pronotum 0.80 times as long as wide; widest at base, sides arcuately converging to a rather strong constriction just behind very broadly rounded anterior margin; basal margin bisinuate; surface smooth and shining on most of discal area, becoming reticulate in all marginal areas and on sides; punctures moderately coarse, close, deep, weakly subcrenulate at base and in lateral areas. Vestiture of rather sparse scales, each scale about six times as long as wide.

Elytra 1.7 times as long as wide, 2.3 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae weakly impressed, punctures small, close, deep; interstriae twice as wide as striae, surface finely rugose-subreticulate, with numerous small, confused, transverse crenulations, each up to one-third width of an interstriae; crenulations near basal margins much as in *Hylurgops*, but margin without a definite row of crenulations. Declivity moderately steep, occupying posterior third of elytra, broadly convex, with areas at apices of interstriae 5-7 slightly elevated; striae more deeply impressed; interstriae 10 reaching declivity. Vestiture of rather abundant, small scales,

each scale very slightly longer than wide, their color pale except small patches of dark brown on declivity.

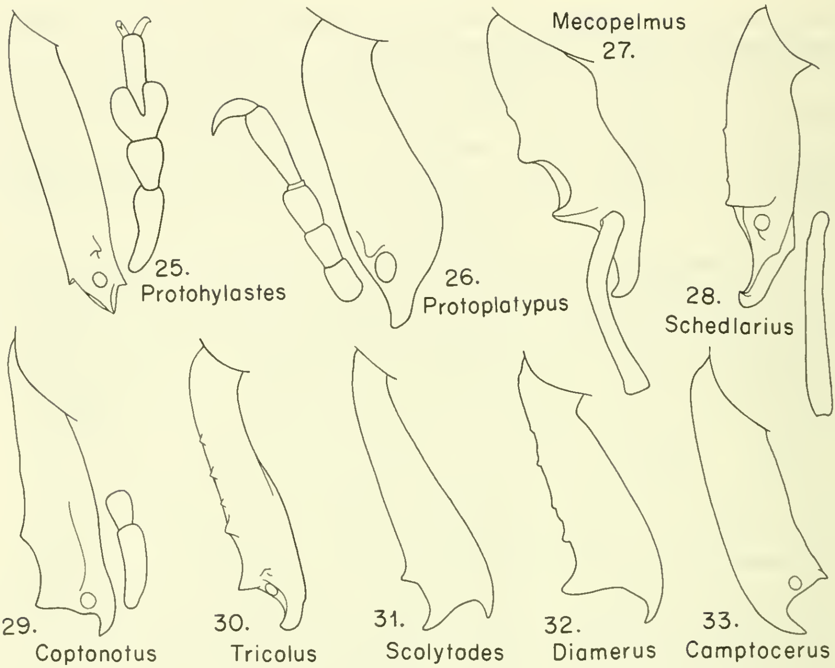
TYPE LOCALITY.— Eungella National Park, Queensland, Australia.

TYPE MATERIAL.— The unique holotype was taken at the type locality on 10-XII-65, by G. Monteith. It is in the Queensland Museum.

Platypodidae

Most platypodids belong to a compact subfamily of highly modified ambrosia beetles. In fundamental structure they differ from scolytids only in degree, not in the kind of characters represented. They share with primitive scolytids the same basic head structure, including a large, well-defined pregula (Figures 8, 17-19). The mouthparts in most of them are highly modified to the ambrosial habit, but primitive forms (Coptonotinae) are comparable to those of scolytids. Virtually identical antennae and pronota are found among primitive forms in the two groups. The protibiae at first appear unique until it is noted that tubercles and ridges appear on the posterior face of the protibiae of some representatives of almost all groups of scolytid woodboring ambrosia beetles. If the minute ridges and tubercles on the posterior face are ignored and the spines and denticles on the apical and lateral margins are emphasized, or if only bark-infesting genera are examined, a graded series of steps apparently bridging the gap between primitive scolytids and primitive platypodids can be demonstrated (Figures 25-33). Since socketed tibial spines characteristic of most scolytids occur only in that group and not in platypodids, only unsocketed spines are considered primitive here.

When the posterior face of the prothoracic tibiae are viewed from exactly the same aspect it is noted that the tarsal insertion is visible near the apex on all Platypodidae, including Coptonotinae, on *Protohylastes*, and on all Scolytini. In *Protoplatypus*, *Mecopelmus*, and *Protohylastes* the tarsus evidently is capable of movement through an arc of almost 180 degrees from the lateral to posterior to mesal positions. In *Coptonotus* and most Scolytini the action is similar but the arc is somewhat smaller. In some Scolytini the tarsal insertion is closer to or even on the apical margin, and greater freedom of movement may occur. In *Schedlarius* the lateral margin of the tarsal insertion is slightly elevated, thus restricting tarsal action more nearly to the posterior to mesal arc; in Platypodinae this arc evidently is even more strongly restricted. In *Aricerus*, *Scolytoplatypus*, and many of the higher Scolytinae, the tarsal insertion is on the apical or lateral margin, and tarsal action apparently is through an arc from the lateral to anterior and possibly posterior positions. In most Hylesininae the tarsal insertion is clearly on the anterior face, and tarsal action is restricted to an arc from the lateral to anterior position or less. A submarginal tubercle on the posterior face near the tarsal insertion in primitive forms appears to have special significance; it is absent in Scolytini and Cossoninae.



Figs. 25-33. Posterior face of prothoracic tibiae: 25, *Protohylastes annosus* Wood, with tarsus, Hylastini; 26, *Protoplatypus vetulus* Wood, with tarsus, Coptonotinae; 27, *Mecopelmus zeteki* Blackman, with first segment of tarsus, Coptonotinae; 28. *Schedlarius mexicanus* Dugès, with first segment of tarsus, Coptonotinae; 29. *Coptonotus cyclops* Chapuis, with first and second tarsal segments, Coptonotinae; 30, *Tricolus peltatus* Wood, Scolytinae; 31, *Scolytodes* sp., Scolytinae; 32, *Diamerus impar* Chapuis, Hylesininae; 33, *Camptocerus auricomus* Blandford, Scolytinae. All drawings were made at different scales so as to be reproduced at a uniform size.

In platypodids the first tarsal segment is supposed to be as long as the remaining segments combined; in some it is actually less than half as long (Schedl, 1939). Representatives of the Coptonotinae (Coptonotidae of Schedl) have the tibiae and tarsi as in some Platypodinae (Platypodidae of Schedl) except that there is greater variability, particularly in the length of the first tarsal segment. One of these, *Schedlarius*, has wood-boring habits, but the larvae, unlike Platypodinae, form independent mines that wander through deep xylem tissues; fungal activity definitely associated with the beetles alters the character of the wood, although there is no mycelial growth in the tunnels that could be used for food as occurs with ambrosia beetles. Another coptonotid, *Mecopelmus* Blackman, is phloeophagous; a large nuptial chamber is formed by the parents in which clusters of eggs are deposited, and larvae then form individual mines that wander in a radiating pattern from this chamber. The genus *Protoplatypus* described above is anatomically rather closely allied

to *Mecopelmus* except that the tarsi are typical of scolytids; as noted above, it is phloeophagous and polygamous.

In most male platypodids, abdominal tergum 8 is of reduced size and is largely or entirely covered by tergum 7 as in the female. In *Schedlarius*, male tergum 8 is more nearly intermediate between the reduced state seen in other platypodids and the normal condition of most scolytids and many curculionids. A reduced male tergum 8 also occurs in the scolytid tribes Ipini (*Ips*, etc.) and Carphodycticini (*Craniodycticus*, etc.). It is doubtful that this reduction in these two tribes indicates a close relationship to platypodids.

The larvae of platypodids and scolytids are inadequately known, but most of them can be segregated using features of the labrum and clypeus. In platypodids the clypeus is broad and strikingly reduced in length or entirely absent and the labrum is proportionately lengthened. In *Schedlarius* and *Protoplatypus* of the Platypodidae and *Carphodycticus* Wood in Scolytidae, the labrum and clypeus are intermediate in size and shape.

In my opinion the platypodids are an aberrant group of ambrosia beetles, as are most other groups of ambrosia beetles within the family Scolytidae, that arose long after scolytid-platypodid characters had been well established. The ambrosial habit has arisen repeatedly within the Scolytidae; for example, *Camptocerus* Erichson (Scolytini), *Scolytoplatypus* Schaufuss (Scolytoplatypini), *Bothrosternus* Eichhoff (Bothrosternini), *Hyleops* Schedl (Hylesinini), and numerous genera in the more highly evolved tribes Xyleborini, Xyloterini, and Corthylini. For this reason, the appearance of the ambrosial habit very early in scolytid phylogeny is not unusual.

Every character on which the family Platypodidae is based, whether anatomical, behavioral, or ecological, intergrades with the Scolytidae. The only justification I see, at present, for retaining it as a family separate from Scolytidae is tradition and the fact that most forms encountered in the field are easily recognized.

Scolytidae

As conceived here, the family Scolytidae consists of the two subfamilies Hylesininae and Scolytinae (including Ipinae). The adult forms of Scolytidae (1) have a definite pregula and pregular sutures, (2) lack a spherical head and rostrum, (3) have a distinctive mandibular articulation (quite different from curculionids?), (4) never have a petiolate point of labial articulation, and (5) have tibiae that are adapted to a bark- or wood-boring habit and, in primitive forms, are no more similar to Cossoninae than they are to those of certain Brenthidae. In part, the similarity between Scolytidae and Rhyncolini is due to convergence or more probably to parallel evolution that commenced when both groups entered part of the same broad ecological niche. The short pseudorostrum of the Hylastini and allied forms of Hylesininae appears to have been acquired independently and differs in fundamental structural detail from that seen in Curculionidae (Figures 1-7).

The division of the Scolytidae (including Platypodidae) into three major lines of development occurred very early in its phyletic history but well after the basic characteristics of the group were established. The earliest living genera representing those lines, *Protoplatypus* and possibly *Mecopelmus* for Platypodidae, *Protohylastes,* and, doubtfully, certain *Cnemonyx* (*galeritus* Eichhoff) for Hylesininae, could appropriately be placed as primitive Scolytinae since they are intermediate and lack some of the most diagnostic characters of the groups I presume they represent.

The argument for the above classification, and also for the retention of Platypodidae and Scolytidae as families, must be considered tentative and biased. It is based largely on a limited number of external adult characters. The larvae, habits, and internal characters of most primitive genera of concern are totally unknown. Collecting experience in tropical areas has demonstrated that specimens of these primitive genera are exceedingly rare and suggests that several more equally rare genera await discovery. It should also be mentioned that in a review of this problem careful attention should be given to the sporadic occurrence of a very short antennal scape, broadly bilobed tarsi, scalelike vestiture, gnathal, and other characters commonly found in primitive genera of these groups. The significance of a complete gula, with two totally separate gular sutures found in several species of the neotropical genus *Gnathotrupes* (Scolytidae) (Figure 12), and the possible cercus-like structures and the tenth abdominal segment of larval platypodids, cited above, must also be investigated. Convergent and parallel evolution among wood-boring Curculionoidea must be examined very carefully in order to sift the meaningful from the misleading superfluous characters found in these families.

Among primitive Coleoptera the tentorial structure arises from two separate tentorial pits on the gular sutures about midway between the foramen magnum and the oral fossa (Stickney, 1923). From these pits the posterior tentorial bridge arises, forming a clearly identifiable internal landmark. The anterior tentorium extends forward from this point for some distance, then branches to form (1) the dorsal arms that extend to but do not fuse with the wall of the head near the anteromesal margin of the eye (connected by ligaments only) and (2) the anterior arms that extend to the anterior tentorial pits near the anterior articulation of the mandibles. In all Curculionoidea having an anterior tentorium the anterior arms extending to the anterior tentorial pits are entirely absent. The dorsal arms vary from well-developed to obsolete. The posterior tentorium in Curculionoidea is carried inward on a Y-shaped apodeme having a median basal portion arising from the median gular suture from the posterior tentorial bridge to the postgula; the two arms of this basal piece branch from its inner margin. The anterior extremity of this internal gular structure forms a single median pillar in all Curculionoidea having a single gular suture and lacking pregular sutures (Figures 1-4). In all Platypodidae and Scolytidae this anterior tentorial structure forms two pillars that continue antero-

laterally along the strongly inflected apodemal ridges formed by the pregular sutures (Figures 5-19). In my opinion this character alone is sufficiently unique and striking, in combination with the external pregular sutures, to warrant family recognition of the group represented by the Platypodidae and Scolytidae.

Summary and Conclusions

The tibial and other characters used as a basis for reducing the Platypodidae and Scolytidae to subfamilies of Curculionidae (Crowson, 1967; Kuschel, 1966) were adaptive characters not found in primitive representatives of the group.

A definite pregula clearly defined by sutures associated with an internal inflection of the cuticle occurs in Platypodidae and Scolytidae but not in any other Curculionoidea having only one gular suture. It is postulated that pregular sutures occur only in those groups in which a rostrum is lacking and has never been developed; therefore, since pregular sutures are absent in all groups with a rostrum, or in which it was secondarily lost, their absence indicates a specialization.

One genus of Platypodidae has the adult maxillary palpus 4-segmented. Since no known representative of the Curculionidae (s. str.) has more than a 3-segmented palpus, the ancestral stock from which the Platypodidae were derived must predate that of the Curculionidae.

Three of the most primitive genera of Platypodidae for which habits are known are either phloeophagous or xylophagous and are not associated with an ambrosial fungus. Since the ambrosial habit has arisen independently many times in the Scolytidae on almost every major phyletic line, it is postulated that the platypodids arose very early from the Scolytidae and now constitute an aberrant group within or very near that family. Tibial, tarsal, and gnathal characters in primitive genera also tend to intergrade in the two groups. Therefore, three major, equally distinctive phyletic lines of development are recognized in Platypodidae (including Coptonotidae), Hylesininae, and Scolytinae (including Ipinae). Platypodidae is tentatively retained as a family separate from Scolytidae for reasons of tradition until exhaustive studies clearly indicate the need for a change.

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STUDIES ON UTAH STONEFLIES (PLECOPTERA)

Richard W. Baumann[1]

ABSTRACT.— Questionable Utah distribution records are reviewed and new state records are given. The female of *Capnia cygna* Jewett is described and figured and an allotype ♀ designated. Detailed synonomies and nomenclatural notes are provided for *Capnia vernalis* (Newport), *Utacapnia poda* (Nebeker and Gaufin) and *Oemopteryx fosketti* (Ricker). Descriptions are given of the female, nymph, and egg of *Isogenoides zionensis* Hanson and an allotype ♀ designated. The male, nymph, and egg of *Pictetiella expansa* (Banks) are described and an allotype ♂ designated. *Sweltsa gaufini*, sp. nov., is described for the male, female, and egg stages and a holotype ♂ designated. Descriptions are either supported with original figures or reference is made to acceptable figures in the literature. Besides line drawings and halftones, useful photographic figures are provided which were prepared by using a scanning electron microscope.

An annotated list of Utah species is given following the revised nomenclature of Illies (1966) and Zwick (1973).

The publication of a monograph on the stoneflies of Utah (Gaufin, Nebeker, and Sessions, 1966) contributed greatly to the knowledge of intermountain Plecoptera. Since this time, however, additions and corrections have been discovered. This study contains this information and includes an annotated list of Utah species.

Detailed synonymies are given for recent nomenclatural changes and where special clarification is necessary. The listing of type specimens and their depositories indicates that they were studied. For further information and complete taxonomic treatment, see Illies (1966) and Zwick (1973).

Malenka flexura (Claassen)

Nemoura flexura Claassen (1923:284). Boulder, Colorado.

This species was recorded by Gaufin et al. (1966) as occurring in Utah. The record was based on one female in the collection of Dr. William E. Ricker, which was collected at Huntsville, Weber Co. The specimen was examined as part of this study and found to belong to *Malenka californica* (Claassen). This does not preclude the possibility that *M. flexura* might be found in the future, but no confirmed records are presently available.

Podmosta decepta (Frison)

Nemoura decepta Frison (1942:13). Estes Park, Colorado.

This species is found in most of the Intermountain states. It was first collected in Utah at the following locality in the Uinta Mountains: small creek 7 miles N Mirror Lake, Hwy. 150, Summit Co., 21-VII-1967, R. W. Baumann, 1 ♂ (NMNH).

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Podmosta delicatula (Claassen)

Nemoura delicatula Claassen (1923:285). Boulder, Colorado.

Specimens of this species were collected by the author during a survey of the stoneflies of the Wasatch Mountains. Since the species was fairly common in small creeks at high altitudes, a closer study was made of the collection at the University of Utah. This resulted in the discovery of other Utah specimens previously included with *Prostoia besametsa* (Ricker). The confirmed records are as follows: Davis Co., Farmington Canyon Creek, 23-VIII-1965, R. W. Baumann, 8 ♀♀ (UU). Duchesne Co., Mirror Lake, 12-VII-1947, L. T. Nielsen, 5 ♀♀ (UU). Rich Co., Allen Canyon, 19-VI-1972, G. F. Knowlton, 1 ♀ (NMNH). Salt Lake Co., Big Cottonwood Creek, Brighton, 16-VII-1952, A. R. Gaufin, 6 ♂♂, 3 ♀♀; 16-VIII-1962, 1 ♂; 6-VIII-1965, R. W. Baumann, 1 ♀; 14-VII-1966, 1 ♀; 29-VII-1967, 1 ♂ (UU) (NMNH). Summit Co., Beaver Creek, Beaver Creek Campground, 1-VII-1959, A. R. Gaufin, 11 ♂♂, 29 ♀♀ (NMNH); Hoop Lake, 30-VI-1958, D. B. Cahill, 1 ♀ (USU); Provo River, below Trial Lake, 5-VIII-1947, A. R. Gaufin, 1 ♀; 6-VIII-1962, 1 ♂ (UU); Smith Morehouse Creek, South Fork Guard Station, 19-VII-1961, A. R. Gaufin, 4 ♂♂, 3 ♀♀ (UU); Weber River, junction Smith-Morehouse Creek, 30-VI-1959, A. R. Gaufin, 12 ♂♂, 29 ♀♀ (NMNH). Wasatch Co., Provo River, Soapstone, 21-VII-1947, A. R. Gaufin, 2 ♀♀; 6-VII-1959, 9 ♂♂, 15 ♀♀ (UU) (NMNH).

Zapada frigida (Claassen)

Nemoura frigida Claassen (1923:285). Sitka, Alaska.

Zapada frigida is never abundant but has a scattered distribution throughout most of the western states. A single male from the Manti-La Sal National Forest is the first Utah record: Johnson Creek, 19 miles N Blanding, Abajo Mountains, San Juan Co., 18-VI-1946, S. B. Muliak (NMNH).

Zapada oregonensis (Claassen)

Nemoura oregonensis Claassen (1923:288). Blitzen Valley, Harney Co., Oregon.

This species was recorded from Utah by Ricker (1952), Gaufin (1955, 1964), Gaufin et al. (1966), and Baumann and Gaufin (1971). The author examined all available specimens of *Z. oregonensis* while studying the Rocky Mountain Nemouridae and found them all to be *Zapada haysi* (Ricker). The species has been confirmed from Idaho, Wyoming, and Colorado, so it is possibly also present in Utah.

Capnia cygna Jewett

Capnia cygna Jewett (1954:546). Washington (?).

The type locality of *C. cygna* is believed to be Washington. Nebeker and Gaufin (1966a) recorded it from Idaho and gave a brief

description and drawing of a female dissected from a mature nymph. Mature females have since been collected, including a single specimen from Mueller Park, Davis Co., Utah, 25-II-1949, R. B. Selander, which is here designated as the allotype ♀ (NMNH). A detailed description and new drawing are included because of the teneral condition of the specimen studied earlier.

Female.— Macropterous. Length of forewings 8-10 mm; length of body 8-10 mm. Body and appendages dark brown almost black, broad membranous dorsal stripe on abdominal tergites 1-8. Wings hyaline; venation typical of genus, with 1-3 crossveins between R_1 and R_2 beyond cord. Eighth sternite with subgenital plate quite simple, heavier sclerotization on both median margins, posterior median margin produced but not extending beyond distal margin of segment, produced portion broadly rounded or slightly angular (Figure 2).

Capnia elongata Claassen

Capnia elongata Claassen (1924:56). Caribou, Plumas Co., California.

The confirmed distribution of this species is along the Pacific Coast, so it probably does not occur in Utah. The specimens that contributed to the Utah records by Knowlton and Harmston (1938), Gaufin (1955), and Gaufin et al. (1966) were found to be *Capnia gracilaria* Claassen.

Capnia vernalis (Newport)

Capnia vernalis Newport (1851:451). Lectotype, male; Albany River. Ontario, Canada (BMNH).

Capnia limata Frison (1944:155). Holotype, male; South Platte River, Littleton, Colorado (INHS).

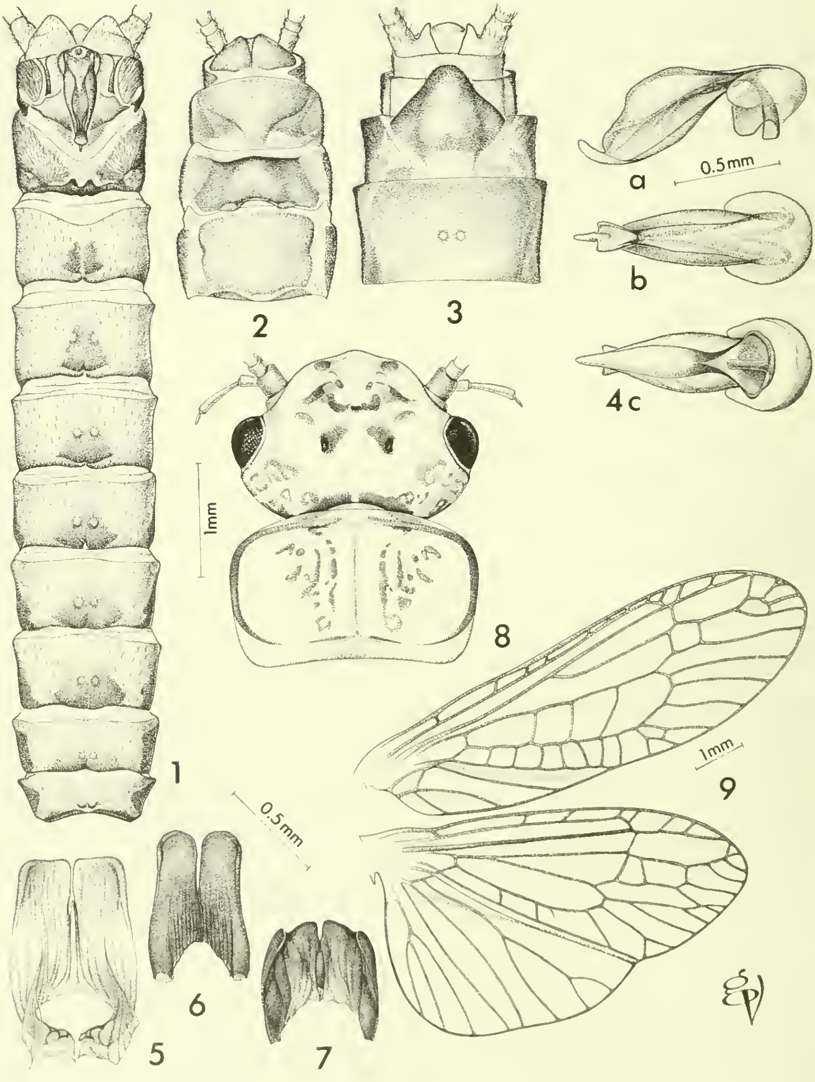
Capnia vernalis: Zwick (1973: ?).

The name *Capnia limata* has been given to specimens from the western United States, while the name *Capnia vernalis* is used in Canada and the northeastern United States. After I examined both type specimens, it was apparent that a single, widely distributed species was involved. This synonymy is recorded in Zwick (1973).

Isocapnia hyalita Ricker

Isocapnia hyalita Ricker (1959:648). Hyalite Creek, Gallatin Co., Montana.

The discovery of this species in Utah is a large range extension, since all previous records are from Montana. It appears to be quite common if sought in the correct habitat at the right time. All records to date are from mountain streams during the months of April and May. The new Utah records are: Utah Co., American Fork Creek, near Timpanogos Cave National Monument, 8-IV-1967, C. D. Bjork and B. R. Oblad, 2 long-winged ♂♂, 1 ♀; 10-IV-1967, 2 long-winged ♂♂, 2 short-winged ♂♂, 2 ♀♀; 12-IV-1967, 1 short-winged ♂, 1 ♀ (NMNH). Tooele Co., South Willow Creek, Upper



Figs. 1, 3-5, 8. *Sweltsa gaufini*, n. sp.: 1, male abdomen, dorsal view; 3, female terminalia, ventral view; 4, epiproct, a. lateral, b. dorsal, c. ventral; 5, leaflike structure on aedeagus; 8, head and pronotum. Fig. 2. *Capnia cygna* Jewett: Female terminalia, ventral view. Fig. 6. *Sweltsa albertensis* (Needham and Claassen): Leaflike structure on aedeagus. Fig. 7. *Sweltsa lamba* (Needham and Claassen): Leaflike structure on aedeagus. Fig. 9. *Pictetiella expansa* (Banks): Right wings of male.

Narrows, 15-V-1967, R. W. Baumann and B. R. Oblad, 5 long-winged ♂♂, 6 short-winged ♂♂, 3 ♀♀ (NMNH).

Utacapnia poda (Nebeker and Gaufin)

Capnia poda Nebeker and Gaufin (1965:475). Holotype, male; Gunnison River, Colorado (UU).

Capnia (Utacapnia) poda Nebeker and Gaufin (1967:226).

Utacapnia poda: Zwick (1973:?).

This species is widely distributed in Colorado, and the collection of a specimen in Utah near the border is not too surprising: Green River, Jensen, Uintah Co., 24-II-1968, R. W. Baumann, 1 ♀ (NMNH).

Oemopteryx fosketti (Ricker)

Brachyptera fosketti Ricker (1965:475). Holotype, male; South Saskatchewan River, Clarksboro, Saskatchewan, Canada (CNC).

Brachyptera zelona Ricker (1965:477). Holotype, male; Myton, Utah (INHS).

Oemopteryx fosketti: Zwick (1973:?).

Oemopteryx zelona was described from one male collected at the Duchesne River in Myton, Utah, which Ricker (1965) erroneously listed as the Green River. Since the holotype was a single male, a special effort was made to collect additional specimens. The examination of several males from Utah led to the synonymy of *O. zelona* under *O. fosketti* included in Zwick (1973). The following records have become available since the original description: Duchesne Co., Duchesne River, Myton, 24-II-1968, R. W. Baumann, 1 ♀ (NMNH); Duchesne River, near Randlett, 24-II-1968, R. W. Baumann, 1 ♂ (NMNH). Uintah Co., Uinta River, Hwy. 40, near Roosevelt, 5-III-1963, A. R. Gaufin, 1 ♀ (UU); Green River, Dinosaur National Monument, 25-III-1967, S. L. Jensen, 3 ♀♀ (NMNH); Green River, Jensen, 24-II-1968, R. W. Baumann, 9 ♂♂, 48 ♀♀ (NMNH); Green River, Ouray, 24-II-1968, R. W. Baumann and G. Z. Jacobi, 9 ♂♂, 8 ♀♀ (NMNH).

Isogenoides zionensis Hanson

Isogenoides zionensis Hanson (1949:109). Holotype, male; Zion National Park, Utah (UMA).

Female.— Macropterous. Length of forewings 21-23 mm; length of body 20-22 mm. Body dark brown dorsally, yellow ventrally; legs brown. Pronotum brown, with broad yellow median stripe. Subgenital plate large, extending ⅓ length of eighth sternite, posterior margin mostly straight, sometimes with small, rounded median projection, lateral corners slightly rounded, forming nearly right angles.

Nymph.— Length of mature ♂ 22-25 mm; mature ♀ 26-29 mm; antennae 7-9 mm; cerci 10-12 mm; with single submental gills 6-7 times as long as wide. Body and legs light brown; occipital ridge

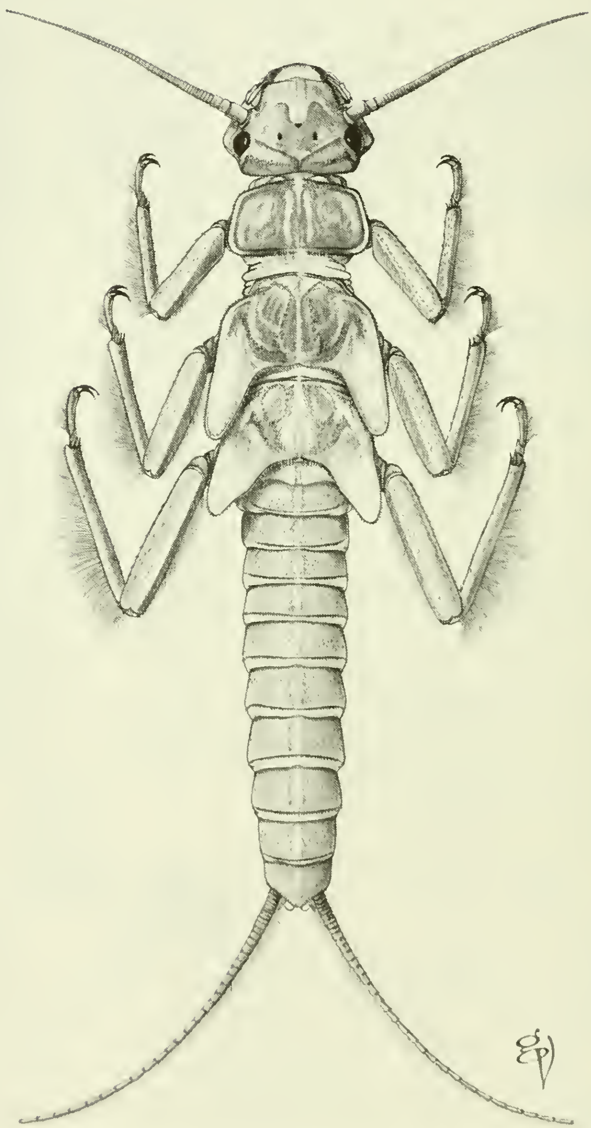


Fig. 10. *Isogenoides zionensis* (Hanson): Mature nymph.

heavy on lateral margins, becoming somewhat thinner towards median line; thin rows of long, light hairs along middorsal line of thorax and abdomen; faint color pattern with small setae on dorsal surface of head and thorax (Figure 10). Mouthparts similar to *I. elongatus* (Hagen). Labium typical in shape for genus, paraglossae covered with long, dense hairs. Maxillae elongate; lacinia with two short teeth, one apical and one subapical, inner margin with sparse row of thin spinules; galea long and narrow; tip rounded and bearing tuft of short spines on ventral half (Figure 13O), extending to base of subapical tooth; palpus five-segmented (Figure 13P). Mandibles rather similar, with two apical and one subapical tooth on each cusp, ventral basal margin of outer cusp with row of stout denticles, narrow patch of fine hairs extending from denticles to base of mandible (Figure 14Q,R), basal margin of inner cusp with dense tuft of long, thin hairs, dorsal surface with rectangular patch of hairs at base of teeth (Figure 14S,T).

Egg.— Average width 350 μ, average length 550 μ. Oval and somewhat elongate, triangular in cross-section, sides equilateral. Collar located at one end, round in shape, with three stabilizing ribs, one at each angle, with broadly rounded, membranous anchor plate when fresh. Microstructure of surface composed of numerous rounded knobs of almost equal size. Micropiles situated at midline in rows of 4-6 running perpendicular to long axis, present on all three sides (Figure 12A,B,C,D).

Isogenoides zionensis was described from five males collected at the Virgin River in Zion National Park. Gaufin et al. (1966) gave figures of a ♂ abdominal tip, ♀ subgenital plate, and nymphal mouth parts but did not include descriptions. They also gave excellent figures of the male genitalia, which were mislabeled as being those of *Isogenus elongatus*. Their figure of the mandible fails to show the denticles on the basal margin of the outer cusp. The labium is shown as bare without the conspicuous covering of dense hairs. The egg is figured in Knight et al. (1965).

The nymph is almost indistinguishable from *I. elongatus* (Hagen) and keys out as such in Ricker (1952), the only known difference being the very light brown almost yellow color of *I. zionensis* as compared to the darker brown of *I. elongatus*. Nymphs are very common throughout the Virgin River drainage of southwestern Utah, but few adults have been collected. The author, after many attempts, was finally able to obtain 2 ♂♂ and 4 ♀♀ from a culvert at the following locality: East Fork Virgin River, Hwy. 89, near Glendale, Kane Co., 23-V-1970, R. W. Baumann (UU) (NMNH). One of the females is here designated as the allotype ♀ (NMNH).

Pictetiella expansa (Banks)

Perla expansa Banks (1920:317). Holotype, female; Grant, Colorado (MCZ), 10,816.

Perla expansa: Needham and Claassen (1925:81, 313, 325) description of ♂ and ♀; figures of wings, ♂ and ♀ genitalia (♂ incorrectly associated).

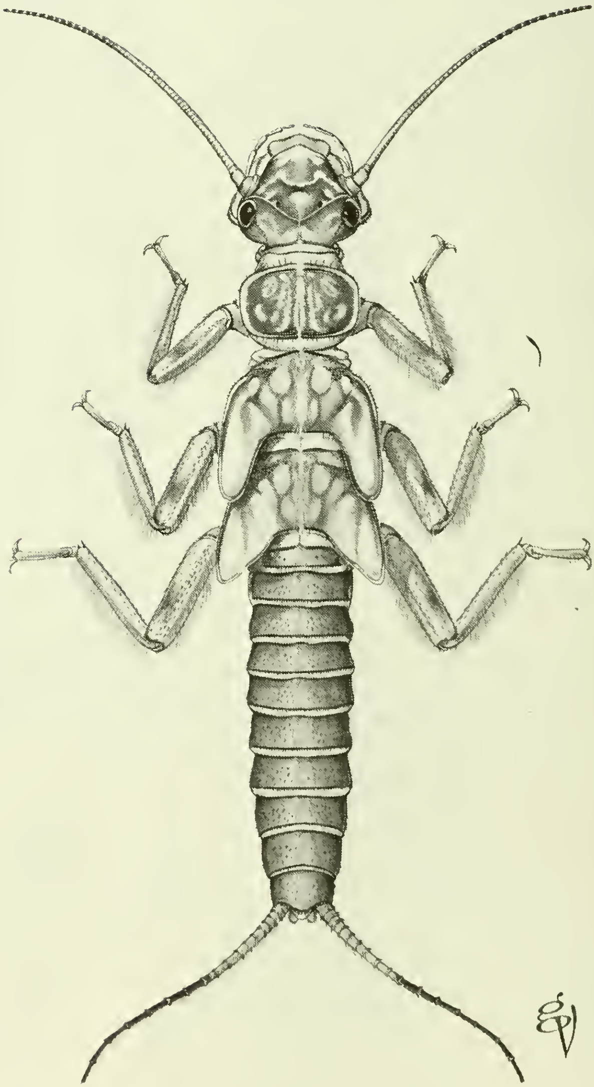


Fig. 11. *Pictetiella expansa* (Banks): Mature nymph.

Perla expansa: Claassen (1931:55) description of nymph (incorrect nymphal association).

Isogenus (*Pictetia*) *expansus*: Ricker (1952:120-122) description of ♂ and nymph; figures of nymphal maxilla and ♂ genitalia.

Pictetiella expansella: Illies (1966:375) (incorrect specific name).

Isogenus (*Pictetia*) *expansus*: Gaufin, Nebeker, and Sessions (1966:62, 64) figures of ♂ and ♀ genitalia.

Male.— Slightly brachypterous. Length of forewings 9-12 mm; length of body 13-16 mm. Body dark brown, last two abdominal segments yellow dorsally; legs yellowish brown; antennae brown; cerci yellow. Head as broad as prothorax, ocellar triangle equilateral, posterior ocelli slightly closer to eyes than to each other, anterior area light yellow, dark brown U-shaped bands connecting lateral ocelli to anterior ocellus, bands extending forward beyond anterior ocellus and laterally from lateral ocelli to form rocking "H," posterior median area yellow, lateral posterior corners brown, palpi brown. Pronotum slightly wider than long, brown with broad yellow median stripe, rugosities rather coarse and restricted to inner ⅔, marginal groove present only at anterior and posterior margins, forming broad anterior and posterior bands. Wings hyaline, with small infuscated area near cord, veins brown, venation slightly aberrant (Figure 9). Abdominal segments normal to ninth, which is narrowed dorsally and greatly extended ventrally at apical margin, ventral extended margin broadly rounded and clothed with fine brown hairs; tenth tergite nearly bisected by deep, sclerotized groove which shields epiproct when not extended. Hemitergites set off from remainder of tergite by angular membranous areas, anterior half of hemitergites covered with long, fine hairs. Epiproct long and narrow with pointed apex, mostly membranous with thin, sclerotized areas visible on dorsal and ventral median areas, patches of small setae on dorsolateral margins.

Nymph.— Length of mature ♂ 15-16 mm; mature ♀ 17-21 mm; antennae 8-9 mm; cerci 7-8 mm; with single submental gills 3-4 times as long as wide. General color brown, but quite strikingly patterned; legs mostly yellow; antennae slightly darker at apex; apical half of cerci very dark brown almost black. Head as wide as pronotum; maxillae barely visible from above; hind ocelli closer to eyes than to each other; occipital ridge as few sparse hairs near lateral margins. Thin rows of hairs running along middorsal line of thorax and abdomen. Head pattern light on dark background: bulb-shaped structure in ocellar triangle, M-line, front of head, lateral tubercles and elongate spot near each eye. Pronotum transversely oval, almost twice as wide as long, outer borders with narrow, dark band fringed with long setae, marginal groove complete but dark along anterior and posterior margins, with distinct light reticulations on dark background. Wing pads on mesonotum and metanotum well developed, outer margins running slightly convergent to body axis, with distinct patches of dark spines along lateral anterior borders, light reticulate markings medially. Abdominal segments fringed with row of dark hairs on posterior margins; faint, narrow, dark

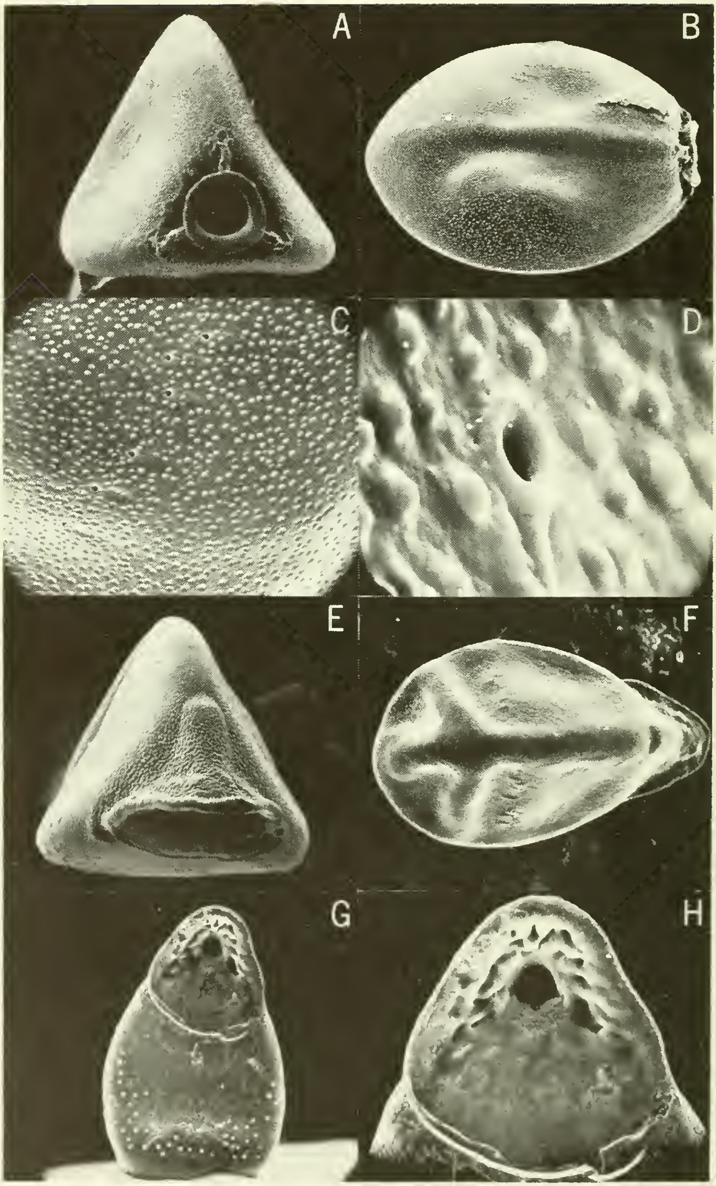


Fig. 12. Eggs. A-D, *Isogenoides zionensis* Hanson: A, collar, end view (240X); B, lateral view (200X); C, micropiles (620X); D, micropile, closeup (6,000X). E-H, *Pictetiella expansa* (Banks): E, collar, end view (270X); F, dorsal view (195X); G, ventral view (180X); H, collar opening, closeup (385X).

bands on anterior margins which are interrupted medially and almost fade out on terminal segments. Cerci with fringes of short hairs at apex of each segment, fringe of long hairs running dorsally throughout entire length (Figure 11). Mouthparts quite distinctive. Labium typical of family Perlodidae, paraglossae covered with long dense hairs. Maxillae elongate; lacinia with two long, narrow teeth, one apical and one subapical, inner margin with few long thin spinules; galea short but elongate, tip pointed and bearing tuft of short spines on ventral half (Figure 13L), extending to base of subapical tooth, palpus five-segmented (Figure 13M,N). Mandibles rather similar, with one subapical and two apical teeth on each cusp, middle teeth with serrated margins, ventral basal margins of outer cusp smooth and bare except for large patch of fine hairs at base of cusp (Figure 14U,V), basal margin of inner cusp with dense tuft of long, thin hairs, dorsal surface with rounded patch of hairs at base of teeth (Figure 14W,X).

Egg.— Average width 300 μ, average length 550 μ. Dorsal aspect nearly oval, axillary lateral ridges extending from median ridge at broadly rounded end to form skewed, cross-like structure, collar end enlarged and rounded. Triangular in cross-section, almost equilateral, but ventral side longest. Collar modified as flat, hood-like structure, convex dorsally, nearly flat ventrally with large opening, anchor plate large, flat, and covering entire ventral surface. Microstructure of surface composed of numerous rounded knobs of almost equal size, knobs arranged in loose, almost circular, designs. Micropiles situated near midline in rows of 5-7 running perpendicular to long axis, those on ventral surface not as obvious. Surface of uncleaned egg covered with small puffball-like structures which, according to Brinck (1949), are special adhesive bodies (Figure 12E,F, G,H).

Pictetiella expansa was named from Colorado from a single female. Since the time of the original description, much confusion has existed as to the identity of this species in both the adult and nymphal stages. Most specimens previously assigned to this species were examined as part of this study, and four genera were represented. This indicated a need for the detailed descriptions of the male, nymph, and egg which are included here. Ricker's (1952) description of a nymph and of teneral male genitalia seem to be correctly associated but are rather general. The figures of the male and female genitalia by Nebeker (Gaufin et al., 1966) were done from specimens used in this study and are excellent. Saether (1970) figures a nymphal maxilla labeled *Isogenus* (*Pictetia*) *expansus* which does not appear to belong in the genus *Pictetiella*.

The genus *Pictetiella* was monotypic and recorded as nearctic until the recent description of *Pictetiella asiatica* from Siberia by Zwick et al. (1972). Records of *P. expansa* have been confirmed from Colorado, Montana, Utah, and Wyoming. The Utah localities are: Salt Lake Co., Parley's Creek above Mountain Dell Reservoir, 5-IV-1963, A. V. Nebeker, nymph (UU); Lambs Canyon Creek,

19-VI-1966, R. W. Baumann, nymphs; 18-VIII-1966, exuviae (UU); Mill Creek, Aug. and Sept. 1965, R. W. Baumann, 12 ♂♂, 15 ♀♀, nymphs; July and Aug. 1966, 7 ♂♂, 8 ♀♀ nymphs (UU) (NMNH); Big Cottonwood Creek, Cardiff Fork, 12-VIII-1966, R. W. Baumann, 2 ♂♂, nymphs (NMNH). Utah Co., Deer Creek, American Fork Canyon, 11-VIII-1966, R. W. Baumann, 1 ♂, 1 ♀. One of the males from Mill Creek Canyon is designated as the allotype ♂ (NMNH).

Alloperla delicata Frison

Alloperla delicata Frison (1935:334). Oak Creek, Corvallis, Oregon.

Alloperla delicata is restricted to the Pacific Northwest in the Coast, Cascade, and Sierra Nevada mountains. The record in Gaufin et al. (1966) from Box Elder Co., Utah, proves to be the common *Alloperla severa*.

Sweltsa gaufini, sp. nov.

Male.— Macropterous. Length of forewings 8-9 mm; length of body 8-10 mm. General color yellow with brown markings; legs yellow; antennae yellow at base and light brown towards apex; cerci yellow. Head slightly narrower than prothorax, ocellar triangle equilateral, posterior ocelli the same distance from each other as from eyes, dark reticulated markings around ocelli which continue to anterior margin and also appear at lateral basal margins (Figure 8). Pronotum wider than long, completely encircled by brown border which is fainter along anterior and posterior margins, median stripe faint, lateral rugosities quite distinctive, posterior border very broad (Figure 8). Wings hyaline, venation typical for genus. Abdomen with broad dark dorsal stripe; ninth tergite with sclerotized, V-shaped process at anterior margin, deeply excavated at posterior margin, ninth sternite greatly expanded and forming ventral plate; tenth tergite completely bisected, bearing lateral sclerotized bars; epiproct mostly membranous: dorsal aspect long and narrow, carina narrower than body with constriction near apex which grades downward to pointed ventral tip; lateral aspect with narrow constriction near broad base, which has lateral discoid appendages, anterior portion becoming very broad just behind apex which bears the pointed tip, basal area with narrow sclerotized ventral projection which is quite broad in lateral view (Figure 4A,B,C). Aedeagus with sclerotized, leaf-like appendage, rectangular in shape, with deep median incision, lateral basal extensions with pointed processes (Figure 5).

Female.— Macropterous. Length of forewings 9-10 mm; length of body 9-11 mm. Color and general morphology similar to male. Subgenital plate formed from posterior median portion of seventh sternite, broad at base, tapering to broadly rounded tip, usually with definite lateral undulations, extending over complete width of eighth sternite, covered with numerous fine hairs, especially apparent at apex (Figure 3).

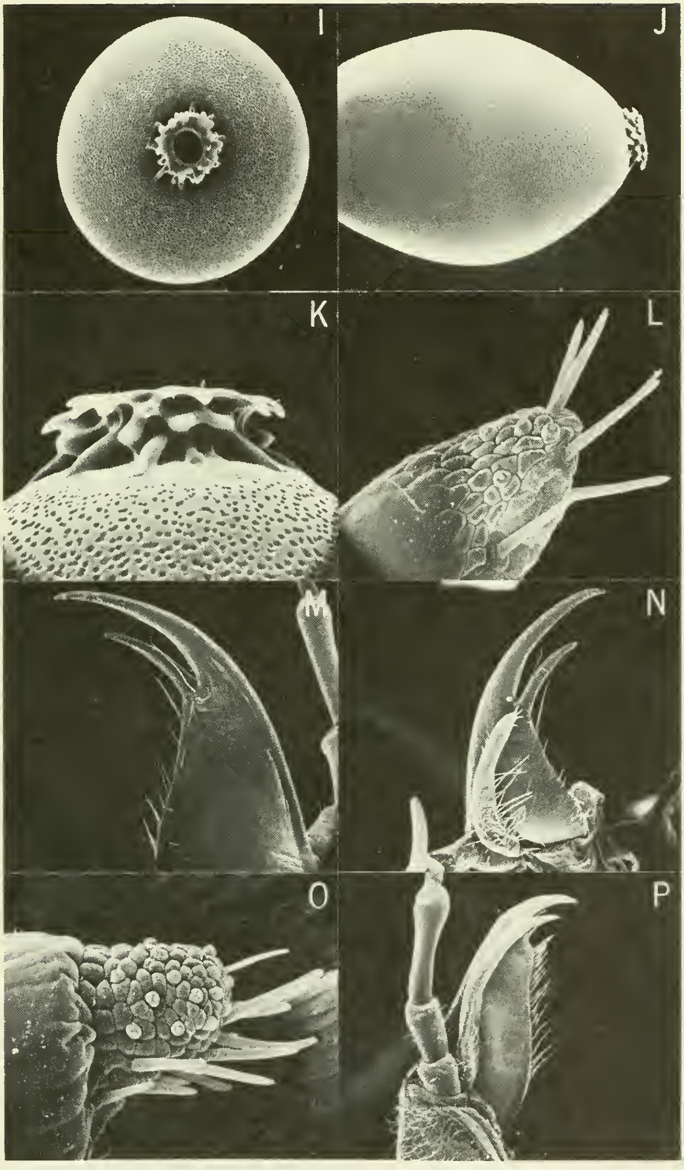


Fig. 13. I-K, *Sweltsa gaufini* n. sp.: I, egg collar, end view (330X); J, egg, lateral view (310X); K, collar, closeup (1,170X). L-N, *Pictetiella expansa* (Banks): L, galea, tip (1,100X); M, left maxilla, ventral (110X); N, left maxilla, dorsal (70X). O and P, *Isogenoides zionensis* Hanson: O, galea, tip (1,100X); P, left maxilla, dorsal (60X).

Egg.— Average width 250 μ, average length 400 μ. Oval and slightly elongate, round in cross-section. Collar terminal, highly modified into many ridges and projections (Figure 13K), covered with round, membranous anchor plate when fresh. Microstructure of surface generally smooth with many small rounded pits, shallow near midline and deeper near poles. Micropiles located below midline on end opposite the collar, occurring as complete, uneven ring (Figure 13I,J).

Sweltsa gaufini is most similar to *S. albertensis* and *S. lamba.* Males can be most easily separated by comparing the leaflike appendage on the aedeagus. The appendage is large, rectangular, and lightly sclerotized in *S. gaufini* (Figure 5); smaller, elongate, and darkly sclerotized in *S. albertensis* (Figure 6); short, broad, and darkly sclerotized in *S. lamba* (Figure 7). Females are presently difficult to separate.

This species is known only from the type locality: holotype ♂, allotype ♀, and 19 ♂♂ and 20 ♀♀ paratypes, Ricks Spring, Logan Canyon, Cache Co., Utah, 29-VIII-1964, A. V. Nebeker (UU) (NMNH). Holotype ♂ No. 72484 and allotype ♀ deposited at the United States National Museum of Natural History, Washington, D.C.

Sweltsa gaufini is named for Dr. Arden R. Gaufin of the University of Utah. Dr. Gaufin introduced me to the Plecoptera and provided direction in my beginning years. It is a pleasure to name a species in the family Chloroperlidae in his honor.

Utah List

The following is a checklist of the 75 Plecoptera species known to occur in Utah using the taxonomic arrangement of Illies (1966) and Zwick (1973).

Nemouridae

Amphinemura banksi Baumann and Gaufin
A. mogollonica Baumann and Gaufin
Malenka californica (Claassen)
M. coloradensis (Banks)
Prostoia besametsa (Ricker)
Podmosta decepta (Frison)
P. delicatula (Claassen)
Zapada cinctipes (Banks)
Z. columbiana (Claassen)
Z. frigida (Claassen)
Z. haysi (Ricker)

Capniidae

Capnia confusa Claassen
C. cygna Jewett
C. gracilaria Claassen
C. nana wasatchae Nebeker and Gaufin
C. uintahi Gaufin
C. utahensis Gaufin and Jewett
C. vernalis Newport
C. wanica Frison

Eucapnopsis brevicauda (Claassen)
Isocapnia crinita (Needham and Claassen)
I. grandis (Banks)
I. hyalita Ricker
I. missourii Ricker
I. vedderensis (Ricker)
Mesocapnia frisoni (Baumann and Gaufin)
Utacapnia logana (Nebeker and Gaufin)
U. lemoniana (Nebeker and Gaufin)
U. poda (Nebeker and Gaufin)

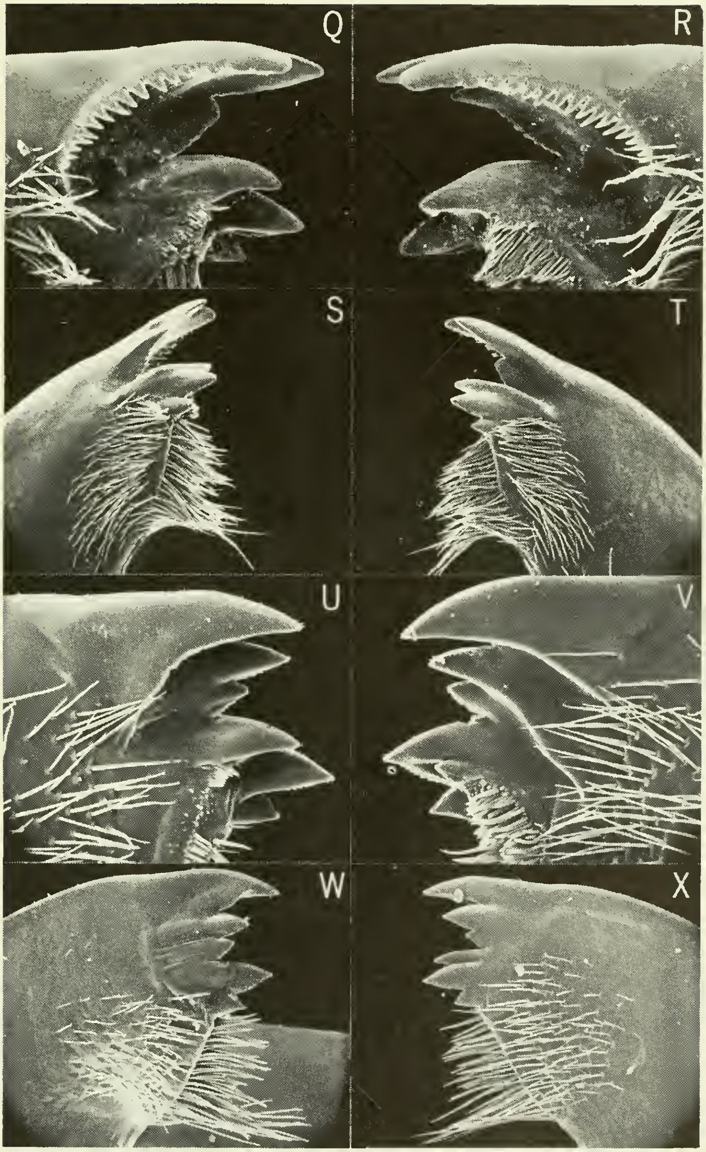


Fig. 14. Q-T, *Isogenoides zionensis* Hanson: Q, right mandible, ventral (200X); R, left mandible, ventral (200X); S, left mandible, dorsal (95X); T, right mandible, dorsal (100X). U-X, *Pictetiella expansa* (Banks): U, right mandible, ventral (260X); V, left mandible, ventral (260X); W, left mandible, dorsal (130X); X, right mandible, dorsal (130X).

Taeniopterygidae

Doddsia occidentalis (Banks)
Oemopteryx fosketti (Ricker)
Taenionema nigripennis (Banks)
T. pacifica (Banks)
T. pallida (Banks)

Leuctridae

Paraleuctra jewetti Nebeker and Gaufin
P. occidentalis (Banks)
P. rickeri Nebeker and Gaufin
P. sara (Claassen)
Perlomyia utahensis Needham and Claassen

Pteronarcidae

Pteronarcella badia (Hagen)
Pteronarcys californica Newport
P. princeps Banks

Perlodidae

Megarcys signata (Hagen)
Skwala parallela (Frison)
Cultus aestivalis (Needham and Claassen)
Isogenoides colubrinus (Hagen)
I. elongatus (Hagen)
I. zionensis Hanson
Kogotus modestus (Banks)
Pictetiella expansa (Banks)
Diura knowltoni (Frison)
Isoperla ebria (Hagen)
I. fulva Claassen
I. longiseta Banks
I. mormona Banks
I. patricia Frison
I. petersoni Needham and Christensen
I. pinta Frison
I. quinquepunctata (Banks)

Chloroperlidae

Paraperla frontalis Banks
Utaperla sopladora Ricker
Alloperla severa Hagen
Suwallia pallidula (Banks)
Sweltsa borealis (Banks)
S. coloradensis (Banks)
S. fidelis (Banks)
S. gaufini Baumann
S. lamba (Needham and Claassen)
Triznaka diversa (Frison)
T. pintada (Ricker)
T. signata (Banks)

Perlidae

Doronuria californica (Banks)
D. theodora (Needham and Claassen)
Hesperoperla pacifica (Banks)
Claassenia sabulosa (Banks)

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The photographic figures were prepared with the aid of Mr. Walter R. Brown and Mary-Jacque Mann of the Smithsonian Institution, Scanning Electron Microscope Laboratory, and Mr. Jarrett L. Cross. The excellent drawings were made by Mr. George L. Venable, staff artist, Department of Entomology, Smithsonian Institution.

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THE MALE BRACHYCISTIDINE WASPS OF THE NEVADA TEST SITE (HYMENOPTERA: TIPHIIDAE)[1]

Marius S. Wasbauer[2]

Brachycistidine wasps are relatively common inhabitants of arid regions in the western United States and may be very abundant locally. There is a strong sexual dimorphism throughout the subfamily. The males are fairly strong fliers and are attracted to various light sources. Because of this, they are well represented in collections of western material. The females, on the other hand, are wingless, strongly fossorial, and probably spend a large proportion of their life cycle underground. They are poorly known. As might be expected, the classification is based principally on the males (Wasbauer, 1966, 1968).

The present study is based on 111 specimens of males from the Nevada Test Site which were made available to me through the kindness of Dr. Dorald Allred, Brigham Young University, Provo, Utah.

The collections made thus far have not been sufficiently intensive to provide information on ecological relationships or seasonal occurrence. The data given here are thus in the form of a list of the brachycistidine taxa found within the boundaries of the Test Site study areas. A statement of general distribution and specific locality records are given for each species. A code designation provided for each specimen collected during the course of the sampling at the Test Site is given in parentheses as part of the specific locality record, and where applicable, a plant association is indicated. Additional information on code designations and biotic communities of the Nevada Test Site may be found in Allred, Beck, and Jorgensen (1963, 1963a).

Genus *Acanthetropis* Wasbauer

Acanthetropis aequalis (Fox).— This species is widespread in the Great Basin. It occurs at least as far north as Idaho and extends eastward into Kansas and Nebraska. Five specimens were seen from the Nevada Test Site. They were all taken from a *Grayia-Lycium* community approx. 35 miles NW Mercury, 22 July 1965, incandescent light and black light [18M(T) and 18M(TB)].

Acanthetropis noctivaga (Bradley).— This species is common in the Colorado and Mojave deserts of California, extending through southern Nevada to Arizona. It occurs also in the Sonoran Desert of mainland Mexico and the Vizcaino Desert of northern Baja California. It has been taken at four areas in the Nevada Test Site: one

[1]Brigham Young University—Atomic Energy Commission Report C00-786-61.
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specimen, 13 miles NW Mercury, 21 July 1965, *Larrea-Franseria* community, black light [401(M)TB]; two specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)]; one specimen, vicinity Mid Valley, approx. 20 miles NW Mercury, 8 August 1965, *Coleogyne* community, black light [17M(TB)]; four specimens, approx. 26 miles NNW Mercury, 27 July 1965, *Coleogyne* community, incandescent light [1M(T)].

Genus *Brachycistis* Fox

Brachycistis glabrella (Cresson).— A common, widespread, and quite variable species, *B. glabrella* has been taken in every state west of the 100th meridian and south of the 45th parallel. In Mexico, it occurs in the Chihuahuan Desert and extends south along the great Central Plateau. It has been taken at two areas in the Nevada Test Site: one specimen, vicinity Rainier Mesa, approx. 36 miles NNW Mercury, 9 August 1965, Piñon-Juniper association, black light [12M(TB)]; two specimens, approx. 20 miles NW Mercury, 8 August 1965, *Coleogyne* community, black light [17M(TB)].

Brachycistis inaequalis Fox.— The distribution of this species is limited to southern and western Arizona, southern Nevada, and the San Joaquin Valley and Colorado and Mojave deserts of California. It has been taken at three areas in the Nevada Test Site: one specimen, vicinity north portion Yucca Flat, approx. 34 miles N Mercury, 28 June 1963, Allred live-catch rodent trap [10SH11(L)]; four specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)]; eight specimens, approx. 26 miles NW Mercury, 16 July 1965, *Coleogyne* community, incandescent light [1M(T)].

Brachycistis ioachinensis Bradley.— This is a somewhat variable species, widespread in the western United States. It has been taken from the Cascades and northern Rocky Mountains, through the Great Basin, the southern deserts as far east as the panhandle of Texas, and well into the Sonoran and Chihuahuan deserts of Mexico. It has been taken at two areas in the Nevada Test Site: one specimen, approx. 26 miles NNW Mercury, 27 July 1965, *Coleogyne* community, incandescent light [1M(T)]; four specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)].

Brachycistis linsleyi Wasbauer.— This is a species of the Sonoran and Chihuahuan deserts of Mexico. It occurs in the Mojave and Colorado deserts of California, through the southern portions of Nevada, Arizona, and New Mexico, and in western Texas. It has been taken at four areas in the Nevada Test Site: two specimens, vicinity Cane Springs, 18 miles NW Mercury, 21 July 1965, *Larrea-Franseria* community, black light [401M (TB)]; one specimen, Mercury, 29 August 1965, *Larrea-Franseria* community, incandescent light [M(T)]; one specimen, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M (TB)]; one specimen,

approx. 26 miles NNW Mercury, 16 July 1965, *Coleogyne* community, incandescent light [1M(T)].

Brachycistis triangularis Fox.— This species is strictly a desert inhabitant, and its distributional pattern coincides almost exactly with that of *B. linsleyi* given above. It has been taken at four areas in the Nevada Test Site: four specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M (TB)]; three specimens, vicinity Cane Springs, 18 miles NW Mercury, 12 June 1965, *Larrea-Franseria* community, black light (CTB); one specimen, same locality, 21 July 1965, incandescent light [401M(T)]; one specimen, approx. 35 miles NW Mercury, 8 August 1965, black light [19M(TB)]; four specimens, approx. 20 miles NW Mercury, 8 August 1965, *Coleogyne* community, black light [17M(TB)].

Genus *Brachycistina* Malloch

Brachycistina acuta Malloch.— This species occurs in the deserts of southern California, southern Nevada, and western Arizona. It has been taken at four areas in the Nevada Test Site: one specimen, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)]; one specimen, approx. 26 miles NNW Mercury 16 July 1965, *Coleogyne* community, incandescent light [1M(T)]; one specimen, vicinity Cane Springs, 18 miles NW Mercury, 21 July 1965, *Larrea-Franseria* community, black light [401M(TB)].

Genus *Colocistis* Krombein

Colocistis brevis (Fox).— This species is a Sonoran Desert inhabitant and occurs in southern California, southern Nevada, and western Arizona. It has been taken at one area in the Nevada Test Site: two specimens, Mercury, 15 August 1965, *Larrea-Franseria* community, incandescent light [M(T)].

Colocistis castanea (Cresson).— This is a large, conspicuous wasp, very abundant in the deserts of southern California, southern Nevada, Arizona, New Mexico, and Texas. This was the most frequently collected brachycistidine wasp at the Nevada Test Site in terms of numbers, but it was taken only in three areas: four specimens, vicinity Cane Springs, 18 miles NW Mercury, 21 July and 9 August 1965, *Larrea-Franseria* community, black light and incandescent light [401M(TB) and 401M(T)]; three specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)]; one specimen, same locality, 20 July 1965, incandescent light [5M(T)]; eight specimens, Mercury, 4-5 August 1965, *Larrea-Franseria* community, black light [M(TB)]; 19 specimens, same locality, 4-25 August 1965, incandescent light [M(T)].

Colocistis crassa (Bradley).— This is another large species which occurs in the Great Basin and throughout the southern deserts of California and Nevada, east to Texas. It has been taken at four areas

in the Nevada Test Site: one specimen, Mercury, 4 August 1965, *Larrea-Franseria* community, incandescent light [5M(T)]; one specimen, vicinity Cane Springs, 12 June 1965, *Larrea-Franseria* community, black light (CTB); one specimen, vicinity Mid Valley, approx. 20 miles NW Mercury, 8 August 1965, *Coleogyne* community, black light [5M(TB)]; seven specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)].

Colocistis eremi (Bradley).— As far as is known, this species occurs only in the southern deserts of California and Nevada. There is one record for the Nevada Test Site: one specimen, 13 miles NW Mercury, 21 July 1965, *Larrea-Franseria* community, black light [401M(TB)].

Genus *Quemaya* Pate

Quemaya paupercula (Bradley).— This is a small, relatively inconspicuous wasp which is restricted, as far as is known, to the southern deserts of California and Nevada. It has been taken at one area in the Nevada Test Site: four specimens, approx. 8 miles N Mercury, 19 July 1965, *Larrea-Franseria* community, black light [5M(TB)].

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NOTES ON AQUATIC AND SEMIAQUATIC HEMIPTERA FROM THE SOUTHWESTERN UNITED STATES (INSECTA: HEMIPTERA)

John T. Polhemus[1]

Abstract.— Notes are given concerning distribution and habitat for *Ochterus barberi* Schell, *Hydrometra aemula* Drake, *Metrobates artus* Anderson, *Metrobates denticornis* Champion, *Rhagovelia becki* Drake and Harris, *Velia beameri* Hungerford, *Velia summersi* Drake, *Abedus* (*Abedus*) *breviceps* Stal, *Abedus* (*Deinostoma*) *herberti* Hidalgo, *Ambrysus buenoi* Usinger, and *Ambrysus thermarum* La Rivers. The following synonymies are noted: *Hydrometra aemula* Drake 1956 = *Hydrometra ciliata* Mychajliw 1961, new synonymy; *Gerris paludum* Fabricius 1794 = *Gerris uhleri* Drake and Hottes 1925, new synonymy. The macropterous form of *Velia beameri* is described.

These notes concern the synonymy and distribution of aquatic and semiaquatic Hemiptera collected mostly by myself during numerous trips to the southwestern states, including southwestern Colorado and parts of Texas. Additional notes are given concerning habitat preferences, and the description of the winged form of one of our *Velias* is included. The material covered here did not seem appropriate for papers already published or in preparation but is limited to those items that seem to offer a significant contribution.

Unless otherwise noted, all specimens are in the Polhemus collection; specimens in other collections will be indicated by the institutional abbreviations given in the acknowledgments.

I am indebted to the following people for help in various ways during the work that led to the preparation of this paper: H. C. Chapman, Lake Charles, La.; the late C. J. Drake; R. C. Froeschner, Smithsonian Institution; J. Herring, USDA, United States National Museum (USNM); H. B. Leech, California Academy of Sciences (CAS); A. S. Menke, USDA, United States National Museum; J. C. Schaffner, Texas A & M University (TAM); J. Schuh, Klamath Falls, Oreg.; P. Wygodzinsky, American Museum of National History (AMNH).

Ochterus barberi Schell

Ochterus barberi Schell, 1943, J. Kansas Ent. Soc. 16:41 (Type ♂, Colorado Canyon, Arizona; USNM).

Heretofore known from Arizona, California, and Mexico, this species was taken in New Mexico. This ochterid is common in the desert areas of Arizona.

Material examined.— Arizona: 2 ♂♂, 1 ♀, 1 nymph, Aravaipa, 8-X-1964, CL315, J. T. Polhemus; 2 ♂♂, 5 miles NE Castle Hot Springs, 7-X-1964, J. T. Polhemus; 1 ♀, Indian Hot Springs, 9-X-1964, CL314, J. T. Polhemus; 1 ♂, Whiteriver, 15-IV-1965,

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CL317, J. T. Polhemus. New Mexico: 2 ♂♂, Gila River, near Gila National Monument, 17-IV-1965, J. T. Polhemus; 1 ♀, Sherman, 17-IV-1965, CL322, J. T. Polhemus.

Hydrometra aemula Drake

Hydrometra aemula Drake, 1956, Proc. Biol. Soc. Wash. 69:153 (Type ♀, Hermosillo, Mexico; Drake Collection, Smithsonian Institution).

Hydrometra ciliata Mychajliw, 1961, J. Kansas Ent. Soc. 34:29. (Type ♂, Guerrero, Mexico; F. H. Snow Entomological Museum, Lawrence, Kansas). *New synonymy.*

The examination of numerous specimens that I had identified as *H. ciliata* has convinced me that *ciliata* is a synonym of *aemula.*[2] Drake described the latter from a single female from Hermosillo, Sonora, Mexico, and Mychajliw described *ciliata* from six specimens from Mexico. The turned-up abdomen of the female and hairy venter of the male separate it immediately from any other species found in the United States; it is new to our fauna.

Material examined.— Arizona: 13 ♂♂, 11 ♀♀, 5 miles NE Castle Hot Springs, CL312, 7-X-1964, J. T. Polhemus; 1 ♂, 1 ♀, E of Castle Hot Springs, CL541, 16-I-1972, J. T. Polhemus.

Gerris paludum Fabricius

Gerris paludum Fabricius, 1794, Ent. Syst. 4:188 (Type sex, locality, and disposition unknown to me).

Gerris uhleri Drake and Hottes, 1925, Proc. Biol. Soc. Wash. 38:69 (Type ♂, "Ariz"; USNM). *New synonymy.*

For a decade I have been disturbed by the inability of myself and others to secure additional specimens of *Gerris uhleri*, which was described, presumably, from "Arizona." Also disturbing was the great similarity between this species and *Gerris paludum* Fabricius from Europe. I examined the type of *uhleri* and confirmed that it is indeed synonymous with *paludum,* but the script label "Ariz" was still puzzling.

Fortunately I found specimens of Old World *Velia* in the collections of the United States National Museum bearing script labels "Ariz" in the same handwriting, reportedly Uhler's, as the label on the type of *uhleri*. Unquestionably the *Velia* originated in the Old World, since the females possess an anal plate which is lacking in the New World species of this genus. Three of the *Velia* were sent to Dr. Livio Tamanini, Rovereto, Italy, who very kindly determined them to be *sauli* Tamanini and *caprai* Tamanini. These specimens correspond with material examined from southern France and western Spain, he said, and there is a river Arize in the Toulouse region in France which would be pronounced "Ariz." It seems most probable that this is the originating locality for the type of *uhleri*. As it

[2] I have now studied the types of *aemula* and *ciliata* and confirmed their synonymy.

now seems certain that *uhleri* originated in the Old World, its synonymy with *paludum* is defensible.

The events described above underscore the importance of maintaining historical collections (all specimens described above bear "PR Uhler Collection" labels) and forewarn of difficulties that may arise if and when the information content of biological collections is computerized and then utilized without proper regard to its origin or to the possibility of error.

MATERIAL EXAMINED.— DENMARK: 2 ♂♂, 2 ♀♀, Lögsö, Rúde Skov, 28-VII-1941, K. O. Leth and E. W. Kaiser. ENGLAND: 1 ♂, Surrey, 6-VII-1941; 1 ♂, Rickmansworth, HT., Batchworth Lake, 26-VII-1953, PNL. FRANCE: 1 ♂, (Holotype, *Gerris uhleri* Drake and Hottes), Ariz, P. R. Uhler Collection (USNM); 1 ♀, Umg. Arcachon, Etang de Cazaux, 11-VI-1954, Weber; 1 ♂, Pyrenees or., Umg, Banyula, 30-V to 10-VI-1953, Gallia mer., H. H. Weber leg.

Metrobates artus Anderson

Metrobates artus Anderson, 1932, J. Kansas Ent. Soc. 5:56 (Type ♂, Cameron County, Texas; F. H. Snow Entomological Museum, Lawrence, Kansas).

This little gerrid is apparently restricted to central and southern Texas, being replaced by *Metrobates trux* Bueno to the west and north and overlapping in range with *Metrobates denticornis* Champion in southern Texas.

MATERIAL EXAMINED.— TEXAS: 2 ♂♂, 3 ♀♀, Altair, Colorado River, CL390, 8-VIII-1967, J. T. Polhemus; 32 ♂♂, 23 ♀♀, Ottine, San Marcos River, CL396, 8-VIII-1967, J. T. Polhemus; 1 ♂, 3 ♀♀, Llano, Llano River, 7-IX-1963, H. R. Burke (TAM, JTP); 1 ♂, 1 ♀, Brownsville, 22-IV-1945.

Metrobates denticornis (Champion)

Trepobatopsis denticornis Champion, 1898, Biol. Cent. Amer. 2:158 (Type ♂, Mexico; Stockholm Museum).

Metrobates denticornis has been previously reported from the United States (New Mexico, Texas) but is apparently rare here. It is a distinctive species with a ventral tubercle on the anterior femur.

MATERIAL EXAMINED.— TEXAS: 5 ♂♂, 4 ♀♀, Big Bend National Park, Reed Camp, Rio Grande River, 25-XI-1971, CL539, J. T. Polhemus.

Rhagovelia becki Drake and Harris

Rhagovelia becki Drake and Harris, 1936, Proc. Biol. Soc. Wash. 49:106 (Type ♂, Sabinas Hidalgo, Nuevo Leon, Mexico; Drake Collection, Smithsonian Institution).

Described from Mexico, this species has been reported previously from Texas. The record from Nevada represents a significant west-

ward extension of its range; the specimens were taken from a runoff stream from hot springs.

Material examined.— Nevada: 12 ♂♂, 20 ♀♀, all apterous, Moapa, Clark Co., CL281, 22-II-1964, J. T. Polhemus.

Velia beameri Hungerford

Velia beameri Hungerford, 1929, Ann. Ent. Soc. Amer. 22:759 (Type ♂, Santa Rita Mtns., Arizona; F. H. Snow Entomological Museum, Lawrence, Kansas).

Velia beameri was originally described from one apterous male and one apterous female from the Santa Rita Mountains, Arizona, and has heretofore been known only from the type specimens.

I collected this veliid near Castle Hot Springs, Arizona, in thick emergent vegetation at the edge of a small pool at the base of a low dam whose impoundment is completely filled with sand. The insects remained hidden in and under the vegetation until it was violently disturbed, whereupon they ran out onto the surface of the water a short distance and then quickly returned to their hiding place. Included in this series is one macropterous female which is described below.

One additional specimen and a nymph were taken by violently sweeping in the dark hollow of a partially submerged tree stump along a tiny, spring-fed streamlet in Aravaipa Canyon, Arizona.

Description: Macropterous female. Body shape, coloration, and hairiness as in apterous forms. Humeri more pronounced but not produced (width, apterous ♀/alate ♀; 40/53). Hemelytra brown, veins prominent; basal white spots of similar length (0.75 mm) to the wing pads in micropterous specimens; V-shaped white mark on apical fourth opening caudad.

Material examined.— Arizona: 18 apterous ♂♂, 10 apterous ♀♀, 1 ♀ macropterous (winged Plesiotype), 4 nymphs, 5 miles NE Castle Hot Springs, CL312, 7-X-1964, J. T. Polhemus; 1 apterous ♀, 1 nymph, Aravaipa Canyon, CL315, 8-X-1964, J. T. Polhemus.

Velia summersi Drake

Velia summersi Drake, 1951, Rev. Ent. (Brazil) 22:371 (Type ♀, Oak Creek Canyon, Arizona; Drake Collection, Smithsonian Institution).

The holotype, a winged female, was described from Oak Creek Canyon, Arizona, and the allotype later described from a small series of specimens taken near Whiteriver, Arizona (Drake, 1957). I took a long series of specimens along the San Francisco River in New Mexico from the pebbles of gravel bars. By splashing water on the shore, the *Velia* were flushed from their hiding places and easily collected as they clambered over the stones or ran rapidly over the water. A diligent search of haunts normally inhabited by *Velia*, such as steeply sloping banks, emergent vegetation, and crevices in

logs failed to yield a single specimen. Several gravel bars along the river yielded specimens, and a few were taken by splashing water into pockets of a sheer rock cliff rising out of the river. Additional specimens were taken from gravel bars in Oak Creek Canyon.

At Seven Springs Canyon north of Phoenix, I searched the gravel bars for this veliid without success in January of 1972 but found many specimens in emergent vegetation in crevices of a sheer rock wall rising from a deep pool. Violent splashing was necessary to dislodge the specimens, and they would make every effort to return to the vegetation. The afternoon temperature was around 50 F in the canyon, with frosty mornings and ice noted in the road ditches: so it is possible that these veliids retreat to this habitat and become more or less dormant in cold periods.

It is worthy of note that all records for this species are from the Salt River-Verde River system. Several closely related species occur in Mexico, with *Velia alvaradana* Drake and Hottes occurring as far north as Sonora, but I have not seen any material collected between the Arizona-Mexico border and Alamos, Sonora.

The left paramere of a male is shown in Figure 1.

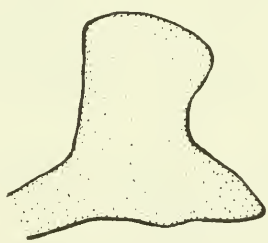

Figure 1. *Velia summersi* Drake, left paramere of male from Whiteriver, Arizona.

MATERIAL EXAMINED.— ARIZONA: About 100 specimens, apterous, N Carefree, 18-I-1972, CL542, J. T. Polhemus; 1 ♂, 1 ♀ apterous, 1 ♀ macropterous, Sedona, Oak Creek Canyon, 9-VI-1969, CL1211, J. T. Polhemus; 1 ♀ apterous, 8-15 miles NE Whiteriver, 8-11-VII-1940, Gertsch and Hood (Part of allotype series, exchange from AMNH). NEW MEXICO: Several hundred apterous specimens, Glenwood, 16-IV-1965, CL319, J. T. Polhemus.

Abedus (*Abedus*) *breviceps* Stål

Abedus breviceps Stål, 1862, Ent. Zeitung 23:462 (Lectotype ♀, Mexico; Riksmuseum, Stockholm).

This species is primarily found in Mexico but has been recorded from Arizona, New Mexico, and Texas.

MATERIAL EXAMINED.— ARIZONA: 3 ♂♂, 3 ♀♀, 1 nymph, Camp Verde, 7-X-1964, CL310, J. T. Polhemus. TEXAS: 1 ♀, 1

nymph, Big Bend National Park, Reed Camp, Rio Grande River, 1-25-X-1971, CL539, J. T. Polhemus.

Abedus (*Deinostoma*) *herberti* Hidalgo

Abedus herberti Hidalgo, 1935, Univ. Kansas Sci. Bull. 22:507 (Type ♂, Tucson, Arizona; F. H. Snow Entomological Museum, Lawrence, Kansas).

Abedus herberti is fairly widespread in Arizona but not commonly found elsewhere. The specimens I have collected vary substantially in size; the smallest male, from Patagonia, measured 28.5 mm in length, while the largest male, from Sedona, measured 38 mm.

Material examined.— Arizona: 1 ♀, 2 nymphs, Patagonia, 25-III-1967, CL1217, J. T. Polhemus; 1 ♂, 4 ♀♀, 2 nymphs, Patagonia, 17-III-1967, CL1218, J. T. Polhemus; 1 ♂, 2 ♀♀, 2 nymphs, Seven Springs, N Carefree, 18-I-1972, CL542, J. T. Polhemus; 1 ♂, 1 ♀, Aravaipa, 8-X-1964, CL315, P. T. Polhemus; 1 ♂, 4 ♀♀, 2 nymphs, Whiteriver, 15-IV-1965, CL317, J. T. Polhemus; 1 ♂, Sedona, 9-VI-1966, CL1211, J. T. Polhemus; 1 ♀, East Fork Verde River, Payson to Pine, Gila Co., 6-IV-1966, J. Schuh; 1 ♂, 4 miles S Patagonia, Santa Cruz Co., Santa Cruz River, 4-IV-1966, J. Schuh; 1 ♀, Santa Cruz Co., 3 miles W Fort Huachuca, 29-V-1969, D. Schuh. New Mexico: 3 ♂♂, 3 ♀♀, Gila River, Gila National Monument, 17-IV-1965, CL323, J. T. Polhemus.

Ambrysus buenoi Usinger

Ambrysus buenoi Usinger, 1946, Univ. Kansas Sci. Bull. 31:199 (Type ♂, Rio Grande, Brewster Co., Texas; USNM).

This species is one of the "free swimming" *Ambrysus* that occur in the slow or still portions of streams. When disturbed, it swims rapidly away in a manner much like most corixids.

Material examined.— Texas: 31 ♂♂, 39 ♀♀, 3 nymphs, Big Bend National Park, Fresno Creek, CL538, 25-XI1971, J. T. Polhemus; 3 ♂♂, 3 ♀♀, Alamito Creek, 5 miles SE Presidio, 13-VI to 11-VII-1968, J. E. Hafernik (JTP, TAM); 1 ♂, 1 ♀, Brewster Co., 21 miles S Alpine, Calamity Creek, 19-VII-1964, D. R. Smith and C. W. Baker.

Ambrysus thermarum La Rivers

Ambrysus thermarum La Rivers, 1953, Proc. U.S. National Museum 103:1 (Type ♂, Hot Springs, Sierra Co., New Mexico; USNM 60987).

The name *thermarum* for this insect, alluding to its occurrence in a hot spring area, is indeed unfortunate, for it occurs in colder water than any other *Ambrysus* known to me. I have collected it only in cold mountain streams in the region of the great caldera northwest of Santa Fe, New Mexico. Presumably, similar streams exist in the mountains west of Hot Springs (now Truth or Conse-

quences), the type locality, and the type series was almost certainly collected from such a habitat. I have not found it in the warmer or slower reaches of any of the streams. *A. thermarum* inhabits the stony, swift-flowing portions of streams, where it may be taken by turning over the rocks and holding the net downstream to catch the dislodged bugs. At Vallecito the water was so cold that my hands ached after a few minutes of collecting in this way.

MATERIAL EXAMINED.— NEW MEXICO: 2 ♂♂, 3 ♀♀, Sandoval Co., Jemez Cr., La Cueva, alt. 7634 feet, 11-VIII-1965, H. B. Leech (JTP, CAS); 3 ♂♂, 3 ♀♀, 3 nymphs, 12 miles W Espanola, 6-VI-1970, CL483, J. T. Polhemus; 3 ♂♂, 2 ♀♀, Canones Creek, 6 miles N Canones, 31-V-1971, CL530, J. T. Polhemus; 9 ♂♂, 9 ♀♀, 5 nymphs, Rio Tusas, Tusas, 9-X-1971, CL535, J. T. Polhemus; 139 specimens, Vallecito, 10-X-1971, CL536, J. T. Polhemus.

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A NEW SUBFRUTICOSE ERIOGONUM (POLYGONACEAE) FROM WESTERN COLORADO

James L. Reveal[1]

Abstract.— A new subfruticose *Eriogonum* (Polygonaceae) is described as E. *pelinophilum*, from specimens obtained near Hotchkiss, Delta Co., Colorado. A member of the subgenus *Eucycla*, the new species is most closely related to *E. contortum* Small ex Rydb., but differs in having cream-colored flowers instead of bright yellow flowers. The two species also differ in that *E. pelinophilum* has narrowly turbinate involucres which are longer than those of *E. contortum* and larger flowers and achenes. The new species is apparently restricted to gumbo clay hills west of Hotchkiss.

In my series of Notes on *Eriogonum*, part VI dealt with the *Eriogonum microthecum* Nutt. portion of the Section Corymbosa Benth. in DC. (Reveal, 1971). In that treatment, I discussed an undescribed species known only from a single collection which occurred on clay hills near Hotchkiss, Delta Co., Colorado. In spite of two attempts to find additional material, the plant could not be located in the field, and the decision was made not to provide formal recognition of this entity until it could be rediscovered and an exact location established.

In July 1972, fieldwork in the Hotchkiss area led to the relocation of this long-sought buckwheat which may now be called:

Eriogonum pelinophilum Reveal, spec. nov. A *Eriogono contorta* Small ex Rydb. floribus albidis et longioribus (2.5) 3-3.5 mm longis, involucris anguste turbinatis (2.5) 3-3.5 mm longis differt. *Plantae* subfruticosae 5-10 cm altae et 8-20 (30) cm latae; *folia* oblanceolata, laminis 5-12 (15) mm longis et 1-2 (3) mm latis, subtus albotomentosis, supra subglabris vel glabris raro floccosis, marginibus revolutis, petiolis brevissimis, 1 mm longis, floccosis vel glabris; *caules* graciles, (3) 5-10 mm longi, floccosi vel glabri; *inflorescentiae* cymosae, 1-2 cm longae et 1-3 cm latae, ramis floccosis vel glabris, radiis 2-7 (10) mm longis; *bracteae* ternatae, 0.5-1 mm longae et latae; *pedunculi* erecti, 1-5 mm longi, floccosi vel glabri; *involucra* solitaria, anguste turbinata, (2.5) 3-3.5 mm longa et 1-1.5 mm lata, floccosa vel glabra, 5-lobatis 0.3-0.4 mm longis, bracteolis oblanceolatis, 1.8-2.5 mm longis, pedicellis 2.5-4.5 mm longis et glabris; *flores* albidi cum costa et funda rufi, (2.5) 3-3.5 mm longi, glabri, tepalis similaribus, oblongis, 0.8-1.2 mm latis; *stamina* exserta, 2.5-4 mm longa, filamentis sparse pilosis basi, antheris albidis, 0.6-0.7 mm longis, oblongis; *achaenia* infuscata, 3-3.5 mm longa.

Low-rounded, heavily branched, pulvinate subshrub 5-10 cm high, 8-20 (30) cm across, the lower woody stems light brown, the bark exfoliating in long loose strips or in wide plates, leafless, arising from a stout, woody taproot, the upper branches herbaceous, slender, floccose to glabrous; *leaves* solitary, scattered along the entire

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length of the herbaceous stems except for the last (3) 5-10 mm, somewhat closely arranged and congested to widely spaced, the leaf-blade oblanceolate, 5-12 (15) mm long, 1-2 (3) mm wide, densely white-tomentose below, the midvein totally obscured by the tomentum, subglabrous to glabrous and green above, the margin entire, revolute and complete enclosing the lower surface, the apex and base acute, the blades persistent throughout the growing season, the petiole short, 1 mm long, light yellowish-brown to tan and thinly pubescent when young, becoming glabrous and brownish at maturity, the petiole-base elongate-triangular, 1-2 mm long, 0.7-1.2 mm wide, slightly pubescent to glabrous and light brown without, densely tomentose within; *flowering stems* erect, slender, 5-10 mm long, floccose to glabrous; *inflorescences* cymose, ± compact and congested, 1-2 cm long and 1-3 cm wide, trichotomous, the rays 2-7 (10) mm long, once or twice divided, floccose to glabrous; *bracts* scalelike, ternate, 0.5-1 mm long and wide, triangular, floccose to glabrous without, thinly tomentose within, connate at the base; *peduncles*, when present, 1-5 mm long, erect, floccose to glabrous, those of the central involucre longest, 3-5 mm long, those of the lateral involucres shorter, up to 2 mm long; *involucres* solitary, narrowly turbinate, (2.5) 3-3.5 mm long, 1-1.5 mm wide, floccose to glabrous without, glabrous within, the 5 acute teeth 0.3-0.4 mm long, the bractlet oblanceolate, 1.8-2.5 mm long, minutely fringed with capitate, gland-tipped cells, the pedicel 2.5-4.5 mm long, glabrous; *flowers* white to cream with reddish-brown midribs and large, conspicuous brownish-red to greenish-red bases, (2.5) 3-3.5 mm long, glabrous within and without except for microscopic glands along the midribs within, the tepals essentially similar, oblong, the outer whorl of tepals 1-1.2 mm wide, the inner whorl 0.8-1 mm wide, the apex of both whorls rounded, united at least ½ the length of the flower; *stamens* slightly exserted, 2.5-4 mm long, the filament sparsely pubescent basally, the anther white to cream, 0.6-0.7 mm long, oblong; *achenes* light brown, 3-3.5 mm long, the globose base tapering abruptly to a long, three-angled beak.

TYPE.— COLORADO: Delta Co.: Along Colorado Highway 92, 8.6 miles west of the western edge of Hotchkiss, 0.9 miles east of the Red Mesa turnoff and 3.1 miles west of Lazear, 11.5 miles east of U.S. Highway 50 at Delta, on rolling clay hills associated with scattered species of *Atriplex* and *Eriogonum lonchophyllum*, at 6400 feet elevation, 16 July 1972, *Reveal and Reveal 2780*. Holotype, US! Isotypes, 30 duplicates to be distributed from US.

Additional specimens examined: COLORADO: Delta Co.: In desert just out of Hotchkiss, 23 July 1958, *Gentry 2283* (COLO).

The Clay-loving Buckwheat, *Eriogonum pelinophilum*, was first thought to be a member of the Section Corymbosa and to be related to *E. bicolor* M. E. Jones (Reveal, 1971). Since seeing the plant in the field, it appears to be more closely related to *E. contortum* Small ex Rydb., a species which is currently placed in an unnamed section typified by *E. brevicaule* Nutt. (Reveal, 1969). The discovery of

this new species now raises serious questions as to the placement of these two species within the genus. Stokes (1936) associated *E. contortum* with those elements around *E. corymbosum*, but the reduced nature of *E. contortum*, its yellow flowers, and smooth greenish stems seem to exclude it from this group of species. However, the flower color of *E. pelinophilum* removes the significance of the flower color, and one is faced with the problem of whether or not one should place both *E. contortum* and *E. pelinophilum* with *E. brevicaule* or with *E. clavellatum* Small and *E. bicolor*. Compounding the problem is the highly reduced, diminutive *E. acaule* Nutt. of Wyoming. Further work is needed before the exact placement of these species can be made, but it is possible that *E. pelinophilum*, *E. contortum*, and *E. acaule* should be placed in a distinct section occupying an intermediate position between those species of the genus typified by *E. microthecum–E. corymbosum* and those related to *E. brevicaule*.

The new species may be distinguished from *Eriogonum contortum* by its white or cream-colored flowers and its longer involucres, flowers, and achenes. *Eriogonum pelinophilum* occurs to the south of all known locations of *E. contortum*, which occupies the Grand Valley of Utah and Colorado. So far as known, *E. pelinophilum* is relatively rare in the field, being restricted to gumbo clay hills and slopes in the desert west of Hotchkiss; no specimens were found to the east and south of this townsite.

Acknowledgment

Field work on the genus *Eriogonum* is supported by National Science Foundation grant GB-22645.

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RECORDS OF COREIDAE (HEMIPTERA) FROM THE NEVADA TEST SITE

Dorald M. Allred[1]

During ecological studies at the Nevada Test Site (Allred, Beck, and Jorgensen, 1963; Beck and Allred, 1968; Knight, 1968), approximately 240 coreids were collected. Although most of these await identification in the U.S. National Museum, Dr. R. C. Froeschner kindly identified some original submittals which are reported herein.

Arhyssus lateralis (Say).— Two specimens, 31-VIII-1959, Frenchman Flat, plant host unknown.

Arhyssus sp.— Twelve specimens: Area 12—26-VIII-1965 ex *Eriogonum* sp.; Area 16—5-20-VIII-1965, ex *E. deflexum;* Area 401 (now Area 26)—16-VIII-1965, ex *E. deflexum;* Cane Springs—25-VI-1959, ex *Asclepias erosa.*

Harmostes angustatus Van Duzee.— Four specimens: Mercury environs—15-VIII-1965, host unknown; Area 2—25-VIII-1964, ex *Pectis papposa.*

Harmostes reflexulus (Say).— Five specimens: Frenchman Flat —31-VIII-1959, host unknown; Area 12—7, 12-VIII-1965, ex *Chrysothamnus viscidiflorus;* Area 16—11-VI-1965, ex *Eurotia lanata;* Area 401 (now Area 26)—18-VI-1965 ex *Sphaeralcea* sp.

Liorhyssus hyalinus (F.).— Twenty specimens: Cane Springs—12-VII-1960, host unknown; Area 5—11-VI-1964. 1964 ex *Sphaeralcea ambigua;* 22-VI-1964, ex *Baileya multiradiata;* 10-VI-1965, ex *Larrea divaricata;* Area 6—19-VII-1965, ex *Eriogonum inflatum;* Area 16—13-VI-1965, ex *Malacothrix glabrata;* 5-VIII-1965, ex *Eriogonum deflexum;* Area 17—11-VI-1965, ex *Astragalus lentiginosus;* 12-VI-1965, ex *Malacothrix glabrata;* 17-VI-1965, ex *Sphaeralcea* sp.; Area 18—23-VIII-1965, ex *Sphaeralcea* sp.; Mercury environs—6-VIII-1965, ex *Eriogonum deflexum;* 15-VII-1965, host unknown.

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DENSITY, GROWTH, AND HOME RANGE OF THE LIZARD *UTA STANSBURIANA STEJNEGERI* IN SOUTHERN DONA ANA COUNTY, NEW MEXICO[1]

Richard D. Worthington[2] and Edward R. Arvizo[3]

Abstract.— Side-blotched lizards. *Uta stansburiana*, were marked and recaptured on a study plot near Anapra. Dona Ana County, New Mexico, during the summer of 1971. The density in July was estimated to be 20.3 individuals per acre (50.2 per hectare). The home range size for males averaged 0.254 acres and for females, 0.097 acres. Males 48-53 mm s-v increased 0.034 mm/day in s-v length and 0.067 mm/day in tail length from middle July to early September. Females 41.5-46 mm s-v increased 0.028 mm/day in s-v length and 0.058 mm/day in tail length during the same period.

During the past hundred years the vegetation of southern New Mexico has changed from a desert grassland climax to a desert climax (York and Dick-Peddie, 1969). Presumably, there have been major changes in the composition of the vertebrate fauna and the relative abundance of different species. Preliminary investigations of the lizard fauna on a study plot located near Anapra, Dona Ana County, New Mexico, were begun during the summer of 1970 in order to determine species composition, relative abundance, and other ecological parameters of the different populations. Data gathered on *Uta stansburiana stejnegeri* during the summer of 1971 have been analyzed and are presented and compared with the results of other investigators.

Methods

A study plot measuring 100 yards to a side (10,000 sq yd; 2.07 acres) was constructed on the morning of 18 July 1971 and marked with numbered and lettered stakes at 50 ft intervals forming 36 quadrats. Observations were begun on the same afternoon. The study plot was worked by two observers on 14 visits and by one observer on two visits through 29 July. Lizards were collected by noosing and marked by toe clipping. Numbers were painted on the backs of lizards with a water-base paint to facilitate recognition with a minimum of recaptures. The point at which the lizard was first seen was noted, and the number of feet to the nearest stake recorded in order that the home range could be reconstructed. The sex, snout-vent length, tail length, and length of any regenerated portion of the tail was determined for each lizard at the time of first capture.

We attempted to estimate density by marking all individuals on the study plot and have followed Tinkle and Woodard (1967) in considering individuals as residents if most of the capture points were within the study plot. The study plot and its immediate periphery were patrolled in different patterns to avoid biasing the observations.

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Only individuals with five or more recapture or sighting points (up to a maximum of 10) during the July period were used for determination of home range. The study area was worked again on three occasions (4-6 Sept.) in order to recapture individuals marked in July for the determination of growth rates.

Two methods were used to describe the vegetation of the study plot. A direct count of the larger plants which could supply cover for the lizards was made. In addition, ten groups of four one-meter-square plots were selected randomly utilizing a random numbers table to determine the quadrat, coin tosses to determine the quarter of the quadrat, and stick toss to determine the one-meter plots. All of the plants were low; therefore, the basal area (shade area) was determined for each individual plant present. Frequency and coverage estimates were calculated. The vegetation analysis was conducted in September, and the area occupied by annuals and other plants that sprouted during the summer rainy season was subtracted in order to approximate plant coverage for July.

Study Area

The study area is in the southern part of Dona Ana County, New Mexico, along the United States-Mexico boundary (lat. 31°47′ 10″N, long. 106°35′05″W). It is situated at the edge of the La Mesa Surface near the Rio Grande and the town of Anapra at an elevation of 1250 m. The area consists of low dunes of windblown sand which attain a maximum height of 1.3 m and which are covered sparsely by vegetation. Larger plants on the study plot providing cover for lizards are 68 *Larrea tridentata*, 52 *Yucca elata*, 27 *Dalea scoparia*, 4 *Prosopis glandulosa*, and 2 *Ephedra* sp. Plant coverage increased from about 19 percent at the time the study was initiated to 31 percent in September. Frequency and percentage of total coverage for plants encountered in 40 one-meter-square plots selected at random are presented in Table 1. Botanical preparations of a majority of the species encountered in the study area have been deposited in the Museum of Arid Land Biology, University of Texas at El Paso.

Table 1. Relative coverage and frequency of plant species determined from one-square-meter plots (N = 40) selected at random in the study area during September 1971.

Name	No. Plants	Relative Coverage	Frequency (%)
Larrea tridentata	17	46.9	18
Salsola kali	20	10.1	30
Amaranthus sp.	41	16.7	53
Sporobolus giganteus	12	3.1	15
Sporobolus flexuosus	4	2.9	10
Erioneuron pulchellum	7	1.1	13
Tidestromia sp.	5	4.3	10
Dalea scoparia	4	9.8	8
Yucca elata	1	4.0	3
Others	8	1.2	10

Weather data for the El Paso International Airport, located about 21 km east of the study area, are available (Orton, 1969). The average annual precipitation is 20.04 cm, about half of which falls between June and September. El Paso averages 101 days a year in which the maximum temperature is 32.2 C or above and only one day a year in which the maximum temperature is 0 C or below. The percentage of possible sunshine is 83. Extremes of temperature range from -22.2 to 41.1 C.

Uta stansburiana is the most abundant lizard on the study plot. Other reptiles collected on the study plot are *Sceloporus undulatus, Phrynosoma cornutum, Cnemidophorus tigris, Crotaphytus wislizeni, Masticophis flagellum*, and *Crotalus viridis*.

Population Density

During July a few hatchlings were beginning to appear in the population. One hatchling was marked and two others were seen; however, they were not included in the population estimates. Estimates pertain only to individuals that have overwintered at least once. The smallest of these individuals was a 39 mm s-v immature male; however, most of the individuals were sexually mature.

A total of 45 lizards were marked. Population estimates based on 42 individuals having all or a majority of capture points within the study plot are 20.3 individuals per acre or 50.2 per hectare. The sex of one individual was not determined, but of the remaining 44 individuals marked, the sex ratio was equal. Turner et al. (1970) found density estimates for four Nevada study plots over a three-year period to vary from 25.7 to 113.1 individuals per hectare. The mean estimates of the four plots for the years 1966 and 1968 show close agreement to the results reported here with estimates of 56.8 and 42.5 individuals per hectare respectively. The 1967 estimate of 80.3 is considerably higher than the Anapra estimate and indicates that wide fluctuations may occur at a given site.

Tinkle and Woodard (1967) compared densities of three populations of *Uta stansburiana* located in Texas, Colorado, and Nevada. Estimates ranged from 12.6 individuals per acre (Nevada, June-July 1964) to 17.5 per acre (Colorado, June-August 1965), which are lower than the Anapra estimate. Other estimates of the size of *Uta stansburiana* populations in Nevada during June (Tanner and Jorgensen, 1963; Tanner and Hopkin, 1972) range from 4.5 to 10.4 individuals per acre and are also lower than reported for Anapra. The El Paso area was experiencing a severe drought just prior to the study, with an official rainfall of less than 2 cm for the first six months of 1971. This suggests the possibility that the estimate of 20.3 individuals per acre may be lower than normal.

Home Range

Home range size estimates were determined from recapture radii (mean radius plus 2s) for individuals with five or more points of capture or sighting. This method is considered the most reliable

for estimating the home range size of *Uta stansburiana*, although there is some disagreement relating to the minimum number of points to be used (Jorgensen and Tanner, 1963; Tinkle, 1967; Tinkle and Woodard, 1967).

The average home range area for 9 males was 0.254 acres (0.046-0.712 acres). The average home range area of 11 females was 0.097 acres (0.016-0.164 acres). These estimates are consistently lower than those reported by Jorgensen and Tanner (1963) and Tinkle and Woodard (1967). Jorgensen and Tanner (1963) report home range sizes of 0.98 acres (adult males), 0.68 acres (adult females), and 0.42 acres (juveniles) for *Uta stansburiana* on the Nevada Test Site. Tinkle and Woodard (1967) report home range sizes for *Uta* in Texas, Colorado, and Nevada ranging from 0.27 acres (Colorado) to 0.50 acres (Texas) for males and 0.12 (Nevada) to 0.23 (Colorado) acres for females. Density figures for the populations studied by Jorgensen and Tanner (1963) and Tinkle and Woodard (1967) are lower than those reported for Anapra. Tinkle (1967) has determined that the juveniles establish home ranges by penetrating and continually expanding their initial home range until they can no longer do so. This suggests an inverse relationship between density and home range size and indicates that the Anapra estimates are comparable to those obtained by other investigators.

Growth

The study area was worked between 4 September and 6 September 1971 to recapture lizards marked during July in order to determine summer growth rates. During the period of July through September, rainfall, plant growth, and presumably insect abundance are maximal. Most, if not all, of the period is within the breeding season of *Uta*, and many of the females collected in July were gravid. Growth data for males and females are summarized in Table 2.

Tanner and Jorgensen (1963), Tanner (1965), Tinkle (1967), and Tanner and Hopkin (1972) present growth data for *Uta stansburiana*. Tinkle (1967) presents daily growth rates of adult *Uta* from near Kermit, Texas. Daily growth rates of 0.17 mm (males) and 0.24 mm (females) for the August-September period and 0.10 mm (males) and 0.32 mm (females) during the June-July period are considerably higher than reported for Anapra lizards (Tinkle, 1967). It is possible that the discrepancy may represent the inclusion of many immature individuals in the size classes Tinkle (1967) constructed, whereas all of the Anapra lizards are reproductive. Growth data for Nevada and Utah *Uta* (Tanner and Jorgensen, 1963; Tanner, 1965; Tanner and Hopkin, 1972) indicate that adults increase in size at rates more comparable to those reported for the Anapra population.

Tail-growth rates as high as 0.13 mm/day for 9 males (46-50 mm s-v) and 0.05 mm/day for 3 females (42-46 mm s-v) are reported by Tinkle (1967) for *Uta* collected during September through November near Kermit, Texas. These rates are comparable to those

determined for Anapra lizards; however, Tinkle's June through August sample rates of 0.01-0.02 mm/day are lower (Table 2). Rates of increase for total length are included for future comparisons (Table 2).

TABLE 2. Daily growth rates of *Uta stansburiana stejnegeri* in southern Dona Ana Co., New Mexico, marked between 18 July and 26 July and recaptured during 4-6 September 1971.

Sex	S-V Size Range July	N	Increase S-V (mm/day)	Increase Tail (mm/day)	Total Increase (mm/day)
Males	48-53	10	0.034	0.067(N=6)	0.105(N=6)
Females	41.5-46	10	0.028	0.058(N=5)	0.099(N=5)

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SMALL BONES OF THE HYPSILOPHODONTID DINOSAUR *DRYOSAURUS ALTUS* FROM THE UPPER JURASSIC OF COLORADO

Peter M. Galton[1] and James A. Jensen[2]

This note reports the discovery of numerous fragments of a small ornithopod dinosaur from the Morrison Formation (Upper Jurassic) of Colorado. This material is referred to the hypsilophodontid *Dryosaurus altus* (Marsh) and represents juvenile individuals of this species.

Very few specimens of hypsilophodontid dinosaurs have been reported from Colorado, and those were found almost a hundred years ago. Marsh (1887a) erected *Nanosaurus agilis* for a specimen (Yale Peabody Museum No. 1913) from Garden City, a few miles north of Cañon City, with material from the Hallopus Beds of probable Upper Jurassic age (Schuchert, 1939). However, the specimen is very fragmentary, with many of the bones represented by natural molds (Huene and Lull, 1908), and it is not demonstrably hypsilophodontid. Marsh (1877b) also described a well-preserved femur (YPM 1915) from the Morrison Formation of Garden City as *Nanosaurus rex*, but Huene and Lull (1908) correctly referred it to the genus *Laosaurus* Marsh.

The new material from Colorado consists of many vertebral fragments and the ends of long bones and metatarsals, the fragmentary condition of which is probably due to the fact that it was collected from the surface rather than *in situ*.

Occurrence.— Near the base of the Upper or Brushy Basin Member of the Morrison Formation (Upper Jurassic), approximately 5.5 miles southwest of Uravan, Montrose County, Colorado.

Collector.— Rodney Scheetz and family.

Repository.— Brigham Young University, Earth Sciences Museum collections (No. ESM-171R).

A selection of the more diagnostic bones is illustrated in Figure 1. All the bones of ESM-171R are very similar to the corresponding elements of YPM 1876, the holotype of the hypsilophodontid dinosaur *Laosaurus altus* Marsh (1878), which is the type species of the genus *Dryosaurus* Marsh (1894). This specimen of *Dryosaurus altus* is from the Morrison Formation at Como Bluff, Wyoming, and it has never been adequately figured. The hypsilophodonts of the Morrison Formation are currently being studied by one of us (Galton), who considers *Dryosaurus* a valid genus. Apart from the form of the teeth and of the femora, the bones of ESM-171R are also very similar to the corresponding elements of *Hypsilophodon*

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Fig. 1. *Dryosaurus altus* (Marsh), referred specimen BYU ESM-171R, Morrison Formation, Colorado. A, fragment of left dentary in medial view; B, distal end of left humerus in posterior view; C, proximal end of left radius in medial view; D, distal end of left radius in medial view; E, proximal end of left femur in posterolateral view; F, distal end of right femur in posterior view; G, proximal end of left femur in anterior view; H, distal end of left femur in anterior view; I, proximal end of right tibia in lateral view; J, distal end of left tibia in anterior view; K, distal end of right tibia in posterior view; L, distal end of left fibula in anterior view; M, proximal surface of left astragalus. A x 2 natural size; B-M natural size; horizontal lines represent 10 mm.

foxii Huxley (Lower Cretaceous, England), the anatomy of which will soon be described in detail (Galton, in press).

There are several jaw fragments containing teeth that are very similar to those of *Dryosaurus*. In the largest fragment (Figure 1A), replacement teeth are visible, and, as shown for most other reptiles by Edmund (1969), the teeth in each alternately numbered series were progressively replaced in sequence from back to front along the jaw, i.e., left to right. There are many isolated centra of dorsal vertebrae, typically ornithopod in form, and the lengths range from 11 mm to 31 mm. The femora (Figures 1E-H) are very similar to those of *Dryosaurus*. Proximally, the lesser trochanter is triangular in cross-section; it is separated from the greater trochanter by a deep cleft (Figure 1G); and distally the anterior intercondylar groove is quite deep (Figure 1H). A rather eroded proximal end is almost twice the size of those illustrated (Figures 1E, 1G).

Assuming similar body proportions to those of the much more complete material of *Hypsilophodon* (see Galton, in press), it is possible to give some idea of the sizes of the individuals represented by the bones of ESM-171R. The smaller of the dorsal centra and the humerus (Figure 1B), radius (Figures 1C, 1D), tibia (Figure 1J), fibula (Figure 1K), and astragalus (Figure 1M) are probably from animals with a body length of about 3 feet (0.9 m). The femora (Figures 1E-H) and tibia (Figure 1I) are probably from individuals that were slightly smaller, and the small tibia (Figure 1K) may be from an animal only 2 feet (0.6 m) long. The large dorsal centra and the eroded femur are probably from an animal about 5.5 feet (1.7 m) long. In contrast, the holotype of *Dryosaurus altus* represents an animal of about 10.5 feet (3.2 m) in length. Specimens representing a series of juvenile individuals are also known for the hypsilophodonts *Dysalotosaurus lettowvorbecki* Pompeckj (Upper Jurassic, Tanzania; see Janensch, 1955) and *Hypsilophodon foxii* (see Galton, in press).

Grateful acknowledgement is made to Rodney Scheetz and his family for discovery of the locality and for generously donating study materials to the Earth Sciences Museum collections. We thank Dr. John H. Ostrom of the Peabody Museum, Yale University (YPM), for permission to study material in the collection under his care. This paper was written while one of us (Galton) was in receipt of a Faculty Research Grant from the University of Bridgeport, and was typed by Tempe Reith (University of Bridgeport).

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ECOLOGY OF *SCELOPORUS MAGISTER* AT THE NEVADA TEST SITE, NYE COUNTY, NEVADA

Wilmer W. Tanner[1] and John E. Krogh[2]

Abstract.— The natural history of *Sceloporus magister* was studied in popu lations at the Nevada Test Site, Mercury. Individuals were marked and kep under surveillance from 1965 through 1970. Reproductive cycles were examine by field observation and by autopsy. Hatchlings appear in the population in Jul and August. Growth is rapid for the first year. Sexual maturity is reached befor the second hibernation or soon after emergence from it. Territoriality is a prc nounced behaviorism; individuals have been observed to remain in a small are for several years. Food consists of arthropods, with ants the predominant iten Reproduction occurs during May and/or June with only one clutch per yea Density is variable and depends on the appropriateness of the habitat.

Sceloporus magister are abundant on the rocky foothills, particu larly where large rocks, wood poles or posts, and tree yuccas ar available for basking and hiding. Several other species of the *spino sus* group have been studied. Blair (1960) studied the rusty lizar (*S. olivaceus*) in Texas for five years; Mayhew (1963) reported o the granite spiny lizard (*S. orcutti*) from southern California afte a four-year study. Other reports involving species of the *spinosu* group have been limited both as to time of observation and materia available. Kauffeld (1943) reported a female *S. clarki* from southern Arizona which contained 24 embryonate eggs. Davis and Smit (1953) stated that *S. horridus* in Morelos seemingly laid one clutc of eggs in late July and the first part of August. Davis and Dixo (1961) indicate a longer reproductive period for this species extend ing from May to September.

Sceloporus magister has not been studied intensively. Severa studies include references to egg laying, large eggs contained in female, and age groups. The studies of Axtell (1959), Minto (1959), Smith, Williams, and Moll (1963), Taylor (1936), Steb bins (1954), and Johnson, Bryant, and Miller (1948) refer to aspect of its life history. A recent and more complete study is by Parke and Pianka (1973).

Fitch (1970) adds information to several species and summarize available reproductive data for the genus *Sceloporus*. Stejnege

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(1893) provides no reproductive data, but does discuss habitat, behavior, and feeding habits. His lengthy comments pertain primarily to the systematics of the larger spiny lizards of the Southwest. *Sceloporus orcutti* and *S. boulengeri* are described as new and other related species (*clarkii, spinosus, magister*) are discussed. Richardson (1915) referred only to the habitat and a few behaviorisms.

In 1939 Smith reviewed the genus *Sceloporus*, described several new subspecies and set forth for the first time a phylogeny of the genus. Phelan and Brattstrom (1955) discussed the geographic variations in *S. magister* and described three new subspecies. Tanner (1955) described as new the Upper Colorado Basin population. Larsen and Tanner (1973) are preparing a phylogenetic study of the entire genus using basically external measurements, scale patterns, and skull characters in a computerized analysis. The populations of this species occur in limited pockets, which may account for their not having been studied as intensively as many other desert species have been.

The present study was conducted at the Nevada Test Site under the contract At(11-1)1496 between the U.S. Atomic Energy Commission and Brigham Young University, Provo, Utah.

Study Plots

Four study areas have been used in securing the data. In each area habitat conditions such as wood poles or posts, large rocks, or trees (tree yuccas or cottonwoods) were present. In two areas the populations were marked and studied from 1965 through 1969.

The Knoll study plot was established in 1965 and the first lizards were marked on 3 July. All captures were made by noosing. The plot consisted of a small rocky ridge rising from the bajada, isolated from the other ranges by a small valley on the west and surrounded otherwise by a desert alluvial plain. The lizards inhabit the ledges and rock slides. Although we succeeded in marking 31 lizards and had 26 recaptures, only one hatchling was seen in four years. The area included in this study plot was approximately 2 hectares.

A study plot at Cane Springs was set up in 1966 and the first lizard marked on 28 May. This plot consisted of two areas. One contained the walls of an old rock house and frame room adjacent to it. These are shaded by a large cottonwood tree. Down the slope to the north are poles and posts and the remains of a corral; nearby to the west are rocks and ledges. In this area captures were made by noosing. The other area was south and west of the house. Near the house is a patch of tall grass and brush, which undoubtedly benefits from the shallow water table near the spring. To the west are sparse desert shrubs on a rocky hillside. Three rows of cans were placed through the grass and onto the hill, totaling 39 traps. Each was placed 12.2 m apart, which provided a plat 147 x 37 m. By including a narrow outer margin to the plot and the area of the house, which is adjacent to the plot, there is approximately .5 hectare. The corral area is about half this size. We marked 67 *S.*

magister at Cane Springs and of these 15 were hatchlings. There were 57 recaptures.

Two areas were used to secure lizards for autopsies. One area consisted of large rocks along the road between Cane Springs and the Knoll. The second was along the abandoned road from Mercury Pass into Frenchman Flat. Along this road are power poles, some ledges, and large boulders. All areas range in elevation between 1075 and 1230 m and are in approximately the same type of habitat except as man has modified it.

Home Range and Density

Data for 15 individuals captured and recaptured for 3-10 times show a definite territoriality. In most instances individuals remained within a rather restricted area, except females who seemingly leave their home range to lay eggs. Both sexes may leave if a more favorable area for hibernation is near the area used for summer activity. The general size and shape of some home ranges observed for periods of 2-4 years were similar to those observed for *S. occidentalis*. The areas occupied were surprisingly small for such a large lizard (Fig. 1). Once a territory was established we observed little shifting or enlarging. An adult female #1K was marked in 1965 and caught once in 1966 and 1967. During these three years she was observed within 4 m of each capture. A juvenile #5K captured 6 times in 1966 and 1967 was within an area having a diameter of not more than 15 m. Two juveniles (#3K and #8K), marked on 29 May and 8 June 1966, moved north along the ridge for approximately 310 and 620 m. Both were recaptured in subsequent years and both remained in a small territory (Fig. 1).

At Cane Springs most of the lizards for which we have adequate data were those living along the rock walls or the rows of posts. Thus their territory consisted of a narrow strip which could not be adequately represented by a polygon. An example is an adult male (#18) marked on 9 July 1966 and last seen on 7 May 1970. During five years he was recaptured nine times and observed at a basking site on numerous occasions. Although our visits to this plot were at intervals of several days and not for long periods of time, only on two occasions did we observe him away from the line of posts, once on a rock pile 20 m west and the last time about 200 m west on a ledge.

Each of these territories possessed at least one area for basking or observing, and, in most, several objects were used. Basking sites were usually near a hiding place. For example, #18 used three posts for basking and observation. He was usually high on the post if not on its top. Our approach would send him scurrying from the post and into one of several large bushes at or near the base of the post. Posts, poles, trees, or rocks were not regularly used if some protection (bushes, rock piles, etc.) were not nearby.

Density is difficult to determine because of the variations in habitat. Although the total area at Cane Springs is smaller than at

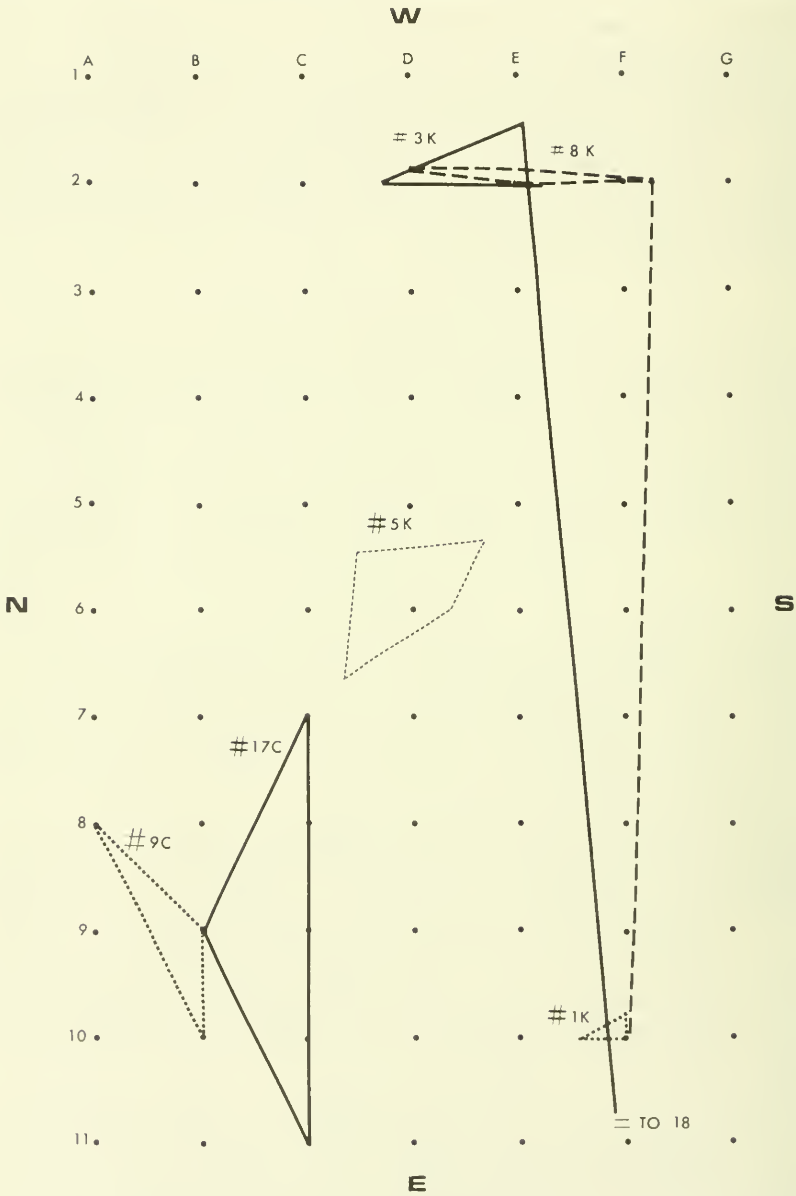

Fig. 1. Home ranges for *Sceloporus magister*. The prefix K = Knoll study plot and C = Cane Springs study plot.

the Knoll, we marked and recaptured 36 more lizards. In 1966 eight lizards were marked at the corral (about 32 per hectare) and 25 at the house and from the can traps (about 50 per hectare). In 1968 seven were at the corral and only 18 at the house and traps. In 1969 twenty were seen at the house and on the plot. During 1966 and 1967 only 12 and 13 individuals were known to be at the Knoll plot (about 6 or 7 per hectare).

Of the three areas for which density data are available, the house and plot area supports the greater density. We recognize in this area more shelter, adequate areas to climb and hide, and because of the abundant vegetation more food. In this species the quality of the habitat is seemingly very important in determining density. Because habitat plays such an important part in the establishment of territories, population densities will vary from a few lizards to as many as 50 per hectare.

Behavior

Desert scaly lizards are active from April to October. Both adults and juveniles were seen 11 April 1970 and adults and hatchlings in mid-September. This species is a persistent basker and may be seen perched on a rock, pole, or some elevated object soon after sunup and until late in the afternoon. During the heat of the day shade is sought. The basking habits are similar to those observed for *S. occidentalis longipes* (Tanner and Hopkin, 1972). Their climbing abilities are remarkable, particularly in trees, where they are very adept at keeping the tree between you and them. In southeastern Utah, this species is so proficient in climbing that collecting is difficult without a gun. In this regard we have found *magister* to be similar to *clarki* and presumably *olivaceus* (Blair, 1960).

Sceloporus magister is a large, heavy-set lizard which usually produces a rustling sound as it scurries for cover. Because of its brisk scampering, ranchers in southern Utah call it the bull lizard. Although it is not as speedy as some lizards, in its habitat of trees, boulders, and poles it is well equipped to escape a pursuer.

Individuals have been recorded to remain on an object for several hours, basking at times and/or loafing in the shade. Often they cling head down as if watching for prey or an approaching enemy.

For active individuals we have cloacal temperatures ranging from 29 to 35 C and averaging 32.8 C. This is within one-tenth of a degree from the average determined for *S. occidentalis* (Tanner and Hopkin, 1972) and only .2 C (32.6) from the mean temperature for a large series of *S. graciosus* from central Utah (Burkholder and Tanner, 1973). We suspect that higher maximum temperatures are reached but question that this species is very tolerant of the high temperatures of other species inhabiting the more open desert area. *Sceloporus magister* seems to confine its activities to areas where shelter and shade are available. Their tree climbing may also contribute to some temperature control by permitting individuals to get well above the intense heat of the desert floor where breezes provide for air circulation.

A male and female, particularly in the spring, often occupy the same basking site. As the season progresses there are fewer pairs seen. Usually by June the courtship is over and females occur singly. Copulation was not observed.

Reproduction

The reproductive cycles in *S. magister* are surprisingly similar to those recorded for *S. occidentalis* (Tanner and Hopkin, 1972) and for *S. graciosus* (Burkholder and Tanner, 1973). Although the general reproductive patterns are similar, there are some variations which will serve to distinguish *magister* from other *Sceloporus* seen by us.

Male Cycle: Although our gonadal series for some months is not large, a plotting of the data does provide a curve which seemingly depicts the cycle (Fig. 2). As in other species in the genus, the cycle moves slowly except for a brief period in June. At this time there is a sudden change resulting in a considerable decrease in gonadal weight and a rapid increase in size and weight of the fat bodies (Table 1). A fat body of five grams was recovered and is unusually large; however, we have other records for weights between two and three grams. In *magister* these large fat bodies are lobate as the liver but are readily distinguished by the grey greenish color.

Courting was observed in May, and pairs were regularly seen occupying the same basking site. The gonadal cycle suggests that mating occurs during May or early June. By mid-June the seminiferous tubes are undergoing a rapid regression, reaching a low point in late July or August (stage 8, after Mayhew, 1971), after which lizards are seen singly and courtship has ceased. The cycle is renewed (stages 1 and 2) in late August and September. We have not seen gonadal examples for late September or October. Examples seen in early April are in stages 4 and 5 suggesting that some development does occur between mid-September and the time of emergence in March. Stages 6 and 7 occur in May and June.

Males are not sexually mature until after the second hibernation. Although growth is rapid and continuous during that first full season, the gonadal cycle does not begin until the late summer and fall before the second hibernation.

Female cycle: Our earliest gonadal samples are for 8 April 1972. On this date the size of testes was much larger than ovaries in comparably sized lizards. The males were more obvious in the habitat and usually were in a dominant position at the basking sites. Indi-

Table 1. Gonadal and fat body cycles in male *S. magister* from the Nevada Test Site.

Cycle	April	May	June early	June late	July	August	Sept.
Gonadal	0.45(4)	0.52	0.51(3)	0.20(4)	0.08(4)	0.035(8)	0.12(3)
Fat Body	0.71		0.12	1.20	1.62	1.36	0.91

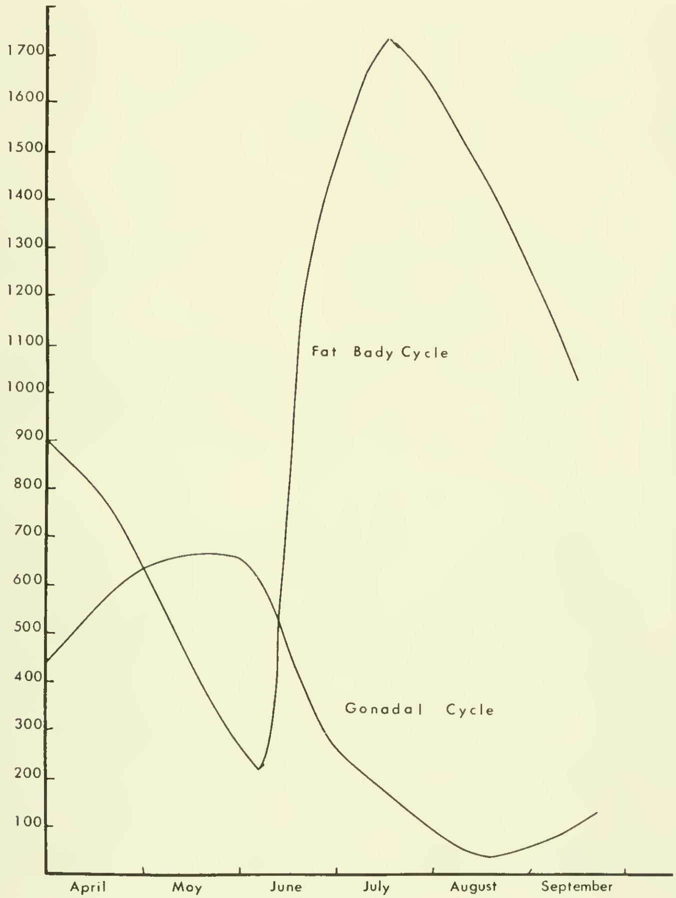

Fig. 2. The reproductive cycle as determined by the weight of testes and fat bodies, plotted in milligrams.

cations are that *magister* female behavior is similar to other northern *Sceloporus* species (*occidentalis* and *graciosus*) in that they emerge after the males have established their territories and are less obvious in the habitat until after mating.

Gravid females were observed in the field during late May and June. In 1966 and 1967 they were seen from 28 May until 16 June. In 1969, they were observed from 10 June to 28 June. Autopsied lizards that year showed oviducal eggs in mid-June. We note one exception in which there were 6 yolking ova, 7 mm in diameter, large fat bodies (1.06), and no corpora lutea for 28 June 1969. She was 97 mm SVL indicating adult size. We have noted an occasional female individual in other species to be slower than most others in a population.

Records for the Mercury Valley plot indicate that adult *S. magister* are in the plot during late May and June; we have only one record for July. Adults entering the plot were two females to each male and with few exceptions they were gravid. We saw one juvenile and five hatchlings during five years. About 300 m west (up slope) from the plot are some ledges and rocky habitat. We believe that the plot and adjacent areas were used as an area for egg laying by migrating females. We have one record in which No. 14 was marked on 11 June 1968, noted to be gravid, and weighed 34.28 g. On 28 June she was not gravid and weighed only 28.54 g. Most individuals were seen only once. Five were seen twice and with one exception (above) were caught within one week.

The study plot data do not satisfy completely our belief that the females of *magister* leave their home territory for depositing eggs as was reported for *S. olivaceus* by Blair (1960). While night driving, we saw a few female *magister* along roads on the test site. Invariably these were gravid females, perhaps attracted to the warm roads as they moved to an area for egg laying.

Four clutches of 4, 7, 7, and 10 eggs were laid in the laboratory on 25 June, 1972 and 20 and 26 June and 20 July, 1973. The clutch of 4 eggs averaged 0.86 (.75-.97)g and were 16.5 x 9 to 17.0 x 10 mm in size. Some captive females are reluctant to lay in confined areas. We suspect that the clutches listed above were held in the oviducts longer than is normal and thus the later dates. Two clutches of oviducal eggs were taken from autopsied lizards on 18 June, 1969. There were five and seven eggs per clutch, averaging 21 x 11 and 18 x 10 mm in size. On the basis of the size and weight of the one clutch, we estimate that the female in Mercury Valley (No. 14) laid six eggs. Available data suggest that the clutch size for *magister* in southern Nevada is in the range of 4-10 (avg. 7) eggs per clutch. This is noticeably less than in such species as *occidentalis* (Tanner and Hopkin, 1972) with 12, *olivaceus* (Blair, 1960) with 10, *clarki* (Kauffeld, 1943) with a record of 24, and *orcutti* (Mayhew, 1963) with 10-12.

Taylor (1936) reports a female from Sonora containing 18 well-developed eggs and Stebbins (1954) lists four clutches from lizards taken in southern California and central Baja California. These range from 7-18 eggs. The size of the females was not recorded and we cannot correlate numbers of eggs to the size (and perhaps the age) of the females. We do note in the size of eggs a relationship to numbers. Data on egg size are available from seven clutches (Stebbins, 1954, 4; our data, 3). The larger eggs were measured in the smaller and medium sized clutches and the smallest in the clutch of 18 eggs.

Apparently only one clutch is laid per year. Yolking and oviducal eggs are found in autopsied lizards from late May through June. None have been found in July. Field data also indicate that gravid females occur in the population from late May to late June but with none in July. In all years studied, by far the greater

number of gravid females was seen during the first two weeks of June.

Records from the literature also place egg laying during late May and June. Apparently this is the case for those populations occurring much farther south than southern Nevada, where the seasons are longer. Although our data and that from the literature are limited, we can see no indications that *S. magister* lays more than one clutch per year.

Soon after ovulation the fat bodies begin to increase in size. They are smallest in late May and until the eggs are laid in June (usually by 20 June). There is not always a complete loss of the fat body. The least we have recorded is 0.06 g on 18 June 1969. By July six females averaged 0.74 g and in August 1.06 g. In none of the females is the fat body as large as those recorded for males during July and August. The fat body cycle is similar to that observed in males (Fig. 2) but with an apparent lag of approximately two weeks after the eggs are ovulated.

Growth and Longevity

Growth

Hatchlings: This age group has been observed from 1966 through 1969. The earliest record for a hatchling is 27 July 1966. In 1969 the first was seen on 28 July. The smallest SVL recorded is 32 mm for one measured at the Mercury Valley plot on 22 August 1966. Two measured 34 mm at Cane Springs on 27 July 1966. The largest hatchling measured 41 mm on 7 August 1966 (Table 2). Although our data are not extensive and are incomplete for the fall months, they do indicate an extended hatching period of approximately one month from late July to late August.

Size of recent hatchlings seems to range in SVL from about 30-35 mm. From this size they grow rapidly, and some approach 50 mm by the time of hibernation. Growth for individuals was not determined; however, if we assume that those measuring 32-34 mm SVL are recent hatchlings (with weights of 1.00-1.50 g) then most hatchlings at least double their weight by the time of hibernation. Lizards having an SVL of 38-41 mm in August weighed 1.75-2.12 g.

Juveniles: More juveniles were captured and recaptured than hatchlings. This was particularly the case for the Knoll, where few hatchlings were seen. Hatchlings were flighty and readily sought cover when approached. Juveniles were bold and seemed to reappear soon after their initial hiding. Growth is rapid after emergence from the first hibernation. In April and May for most years measure-

Table 2. Range and average SVL for twenty hatchlings from the Cane Springs and Mercury Valley study plots.

Year	No.	Males	No.	Females
1966C	5	37.2(34-41)	3	36.3(34-37)
1968C	2	36.5(36-37)	5	36.2(34-38)
1966M	3	37.2(35-40)	2	34.0(32-36)

TABLE 3. Range and average SVL for thirty-seven juveniles. (K = Knoll, C = Cane Springs, F = Frenchman Flat)

Year	No.	Males	No.	Females
1966K	5	65.4(57-70)	2	62.5(62-63)
1967K	3	63.7(60-66)	3	53.7(50-57)
1968K			3	62.3(59-68)
1969K	2	73.0(71-78)	3	75.0(71-77)
1966C	2	67.5(65-70)	5	57.6(53-60)
1967C			2	61.0(59-63)
1970F	4	58.2(52-66)	3	60.0(55-65)
Total/Avg.	16	64.5(52-78)	21	61.2(53-77)

ments for SVL range between 50 and 60 mm, with a few in the low sixties. In Table 3 juvenile SVL measurements include those for April through July. August measurements are usually in the seventies and some individuals are approaching the size of adults and exhibit an adult color pattern.

Table 4 provides growth data for ten individuals. In most cases growth approximated 0.3 mm per day or a growth during May, June, and July of 25-30 mm. Such a growth rate is not attained by all individuals. We also note a slowing of the rate in July, perhaps because of a reduced food supply resulting from the hot and dry conditions which usually prevail. Late springs may retard the rate early in the season whereas an early spring provides for a rapid as well as a longer growth period.

TABLE 4. Measurements and growth rates for selected juveniles after the first hibernation. (C = Cane Springs, K = Knoll)

Toe Number	Date	Sex	SVL	Days Growth	Total Growth	Growth per day
7C	12 June 66	F	53			
	17 July 66		65	35	12mm	0.343
9C	16 June 66	F	60			
	25 July 66		75	39	15mm	0.384
11C	20 June 66	F	60			
	15 July 66		72	25	12mm	0.480
1-6C	16 June 67	F	63			
	7 Aug. 67		82	52	19mm	0.365
2-8C	17 June 68	F	59			
	9 July 68		67	22	8mm	0.364
2-9C	17 June 68	F	68			
	28 June 68		70	11	2mm	0.182
2-13C	9 July 68	F	69			
	2 Aug. 68		74	24	5mm	0.208
5K	31 May 66	M	57			
	15 July 66		72	45	15mm	0.333
4K	31 May 66	M	68			
	15 July 66		83	45	15mm	0.333
8K	8 June 66	F	63			
	29 June 66		65	21	2mm	0.095
	Total/Avg.			319	105mm	0.333

TABLE 5. Measurements for adults from four study plots at Nevada Test Site for the years 1965 through 1971.

Plot	No.	Males	No.	Females
Cane Springs	16	98.6(84-114)	20	93.2(88-102)
Frenchman Flat	22	101.6(87-112)	20	97.6(91-107)
The Knoll	11	97.4(83-115)	7	92.0(81-102)
Mercury Valley	4	96.0(90-100)	10	95.8(88-103)
Total/Avg.	53	99.40	57	95.04

Juveniles reach adult size by the time they hibernate in October. In September the gonadal cycle is paralleling that of adults and, except for a smaller size, these juveniles are functionally adults.

Adults: There is a slight sexual dimorphism in size with males averaging approximately 5 mm larger in SV lengths (Table 5). The smallest sexually mature female was 81 mm and the smallest adult male recorded was 83 mm SVL. The largest individuals in the population are males (Table 5). Data indicate that few females yolk eggs before they are approximately 90 mm SVL.

Adults continue to grow for at least three years. Young adults emerging from the second hibernation usually have a sustained growth for the first three months (April through June). This is not as great a growth in length as in hatchlings and juveniles; however, it does result in a noticeable increase in weight. By this time they have reached full adult size (90-100 mm) and have completed the first reproductive cycle. Examples of growth after the second hibernation are listed in Table 6. Records for individuals more than 30 months old show them to be 90 mm or more in SVL. A male individual from Cane Springs (18) marked on 9 July 1966 was 87 mm SVL, and estimated to be about 23 months old since no other juvenile seen by us reached such a size before late August. On 4 June 1968 he was 110 mm and on 7 May 1970, 114 mm. Although some individuals grow more rapidly than others, our data indicate that individuals measuring 100 mm or more in SVL are the older members of the population perhaps 4 or more years of age.

TABLE 6. Measurements and growth rates for selected individuals as juveniles and as adults after the second hibernation. (K = Knoll)

Toe Number	Date	Sex	SVL	Total Growth	Age (approximation)
3K	29 May 66	F	62		10 mo
	1 June 67		81	19mm	22 mo
5K	31 May 66	M	57		10 mo
	2 June 67		82	25mm	22 mo
8K	29 June 66	F	65		11 mo
	10 July 67		87	22mm	23 mo
19K	13 July 67	M	66		11 mo
	4 June 68		88	22mm	22 mo
1-5K	19 June 68	F	60		11 mo
	28 June 69		86	26mm	23 mo

Longevity

We have one record for a male known to be in his sixth year. Two males were marked at Cane Springs on 9 July 1966. Number 17 was a large adult, 110 mm SVL weighing 54 g. We estimate him to be at least 4 years old when marked. He was last seen on 15 June 1968, the same length but only 48 g. Number 18 was smaller, measuring 87 mm SVL and weighing 24 g. He was in his first year as an adult. He was last seen on 7 May 1970, appeared to be healthy, and weighed 59.13 g. Several records are for four years and two for at least five years.

Records for marked individuals and for those compared when autopsied indicate that the adult population consists mostly of lizards 3-5 years old but with a few older ones. The two oldest are both males; however, we do not consider this to imply that males live longer than females. The oldest females were 4 years. Our data are too limited to establish longevity differences between the sexes.

Food and Feeding Habits

This species is primarily an insectivorous feeder. Fig. 3 lists the types of food eaten as a percentage of individual items consumed. Only stomach contents were analyzed. Knowlton and Thomas (1934) and Knowlton and Nye (1946) reported on the contents of 49 and 12 stomachs from southern Utah. In both studies, ants were dominant food items. The desert scaly lizard, as with other sceloporines we have examined, is an opportunistic feeder. One adult male contained 1129 small ants. Four adults had eaten Isoptera and in each case large numbers (78-330) were consumed. The usual variety of arthropods are included in the diet throughout the year with an apparent increase in ants during July. This we do not understand unless it is attributable to the decline of vegetation (annuals and spring perennials) and the decline of insects as a result of the heat and drought; these conditions have apparently little effect

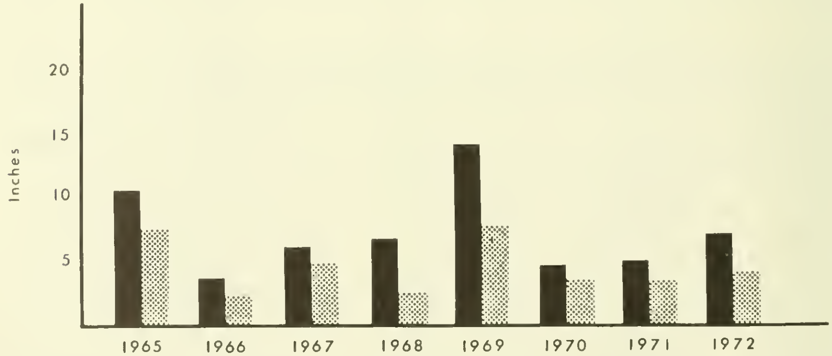

Fig. 3. Precipitation for an eight-year period 1965 to 1972. Dark columns for Cane Springs, dots for Well 5B (weatherstations in Frenchman Flat).

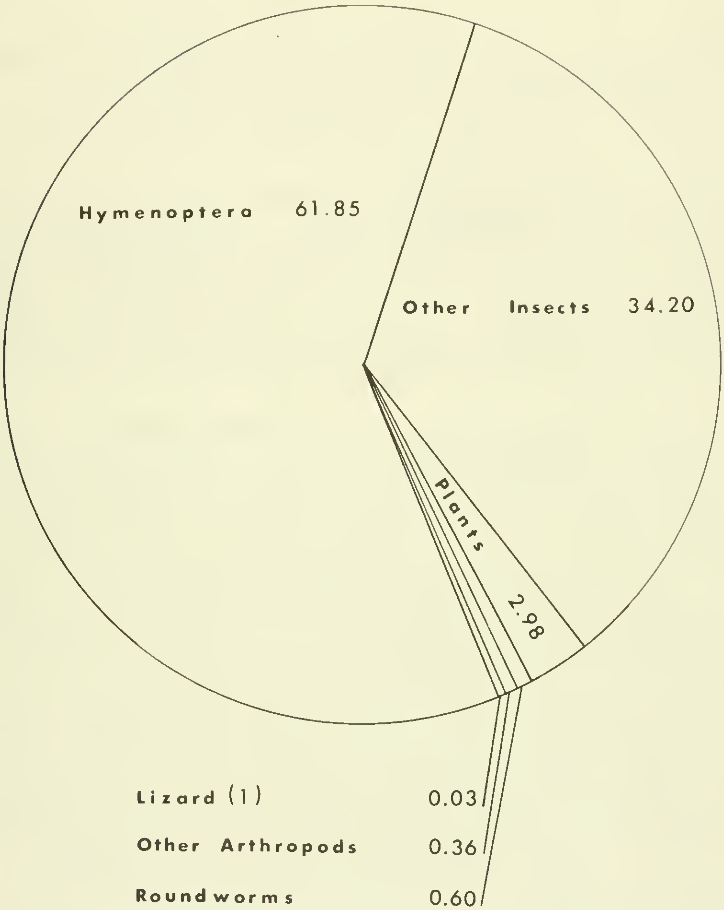

Fig. 4. Stomach contents plotted as a percentage of the items found in twenty-one stomachs in 1969.

in reducing the numbers of ants. Eighteen of 22 stomachs contained ants, which is higher than the ratio (29 of 49) found by Knowlton and Nye (1946). Knowlton and Thomas (1934) found one small *Cnemidophorus t. tigris* and some seeds and berries in stomach contents. We found one hatchling *S. magister;* we also found that several had consumed a number of plant parts, including 21 *Lycium* berries, a number of small rocks, and 18 round worms. A general list of the items recovered is in Fig. 4.

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FURTHER STUDIES ON THE WASPS OF JACKSON HOLE, WYOMING (HYMENOPTERA, ACULEATA)

Howard E. Evans[1]

Abstract.— In a report published in 1970, 190 species of wasps were reported from Jackson Hole, Wyoming, and notes were presented on the biology of several ground-nesting species. In this paper, records of 18 additional species are presented. A short account of the biology of a ground-nesting species, *Tachysphex aethiops* Cresson, is included. Also included are accounts of four species that accepted wooden trap nests during the summer of 1971: *Symmorphus cristatus* (Saussure), *Ancistrocerus adiabatus* (Saussure), both Eumenidae; *Trypoxylon aldrichi* Sandhouse, *Passaloecus cuspidatus* Smith, both Sphecidae. Notes are presented on nest structure, prey, and parasites in each instance.

This is a brief supplement to my study of the ecology and behavior of the wasps of Jackson Hole, Wyoming (Evans, 1970). That paper summarized three summers of study over a six-year period (1961-1967). I returned to Jackson Hole in the summer of 1971, primarily to round out my work on the digger wasp genus *Philanthus*. My data on *Philanthus* will be saved for a proposed survey of the comparative behavior of members of that genus. The present paper includes additions to the faunal list and notes on the nesting behavior of five species not or only briefly studied earlier.

In my 1970 paper I reported 190 species of wasps from Jackson Hole. Eighteen species are here added to the list, bringing the total to 208. Since my earlier studies were concerned with ground-nesting wasps, I put out 300 wooden trap nests in 1971, hoping to learn something of the distribution and behavior of twig-nesting species. Although the percentage of acceptance was high, only four species of wasps occupied these nests. The results of the trap-nesting work are summarized in the last section of this paper.

A general description of the study areas will be found in my 1970 paper. Study area no. 3, listed as 4 miles SW of the Elk post office and indicated by the word *Elk* in the text of that paper, should perhaps be qualified, since there is evidently no longer a post office at Elk. This area is on the Snake River some 9.5 km southwest of Moran Junction, about 11 km south of the research station. For the sake of consistency, I have continued to call it Elk in the present paper.

I am, as usual, much indebted to the authorities of Grand Teton National Park for permission to collect specimens for identification, and particularly to the staff of the Jackson Hole Biological Research Station for use of their facilities. I am indebted to several specialists for identifying certain Sphecidae: Frank Parker (Astatinae), David Vincent (*Passaloecus*), Richard Bohart (*Gorytes*), and Joanne E. Slanky (*Nitelopterus*). Insect prey were identified by specialists of the Entomology Research Laboratory, U.S. Department of Agri-

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culture, as indicated in the text. Spider prey were identified by H. W. Levi of the Museum of Comparative Zoology.

I. Additions to the Faunal List

Family Chrysididae

Omalus cressoni (Aaron). Pilgrim Creek, 1 ♀, note no. 2299B: trap-nest collected 22 Aug. 1971, 1 ♀ emerged 7 May 1972 (nest was that of *Passaloecus cuspidatus;* female of host had emerged 24 April 1972).

Family Tiphiidae

Publication of Allen's (1971) study of the genus *Tiphia* in western North America permits me to clarify the species listed as "near *essigi*" and to add two additional species to the list.

Tiphia anguis Allen. This species was described by Allen (1971), the ♂ holotype and several paratypes (2 ♀♀, 3 ♂♂) being from Elk, 4-10 July 1964, with additional paratypes from Moran (1 ♀, 1 ♂, 11 Aug. 1964) and from Jenny Lake (1 ♀, 20 July 1936).

Tiphia barberi Allen. Allen reports 3 ♀♀ and 1 ♂ from the Grand Tetons, collected by E. C. VanDyke in June 1938.

Tiphia nevadana Cameron. This is a senior synonym of *T. essigi* Allen, and the records for "sp. near *essigi*" from Moran and Elk should be transferred to this species; they are so recorded by Allen (1971).

Family Masaridae

Pseudomasaris marginalis (Cresson). Death Canyon, 17 July 1971, 3 ♀♀, 2 ♂♂, ♀♀ on *Phacelia sericea.*

Pseudomasaris zonalis (Cresson). Pilgrim Creek, 2 Aug. 1971, 2 ♀♀, 2 ♂♂; Death Canyon, 17 July 1971, 2 ♀♀, 1 ♂.

Family Pompilidae

Anoplius (*Pompilinus*) *insolens* (Banks). Signal Mt., 7300-7700 feet, 28 July 1971, 1 ♀.

Family Sphecidae

Subfamily Pemphredoninae

Passaloecus relativus Fox. This species should be deleted from my original list. David Vincent, of Utah State University, is currently studying this genus and has examined the specimens reported as *P. relativus* and found them to consist of the following three species.

Passaloecus cuspidatus Smith. Moran, 6 July - 23 Aug. 1964, 1967, 4 ♀♀, 2 ♂♂, 1 ♀, note no. 1992: taken as prey of *Philanthus pulcher;* Huckleberry Hot Springs, 11-31 Aug. 1967, 2 ♀♀; Snake River, Elk, 9 Aug. 1967, 1 ♀, note no. 2144: taken as prey of *Philanthus pacificus.* This species accepted trap nests in considerable numbers during 1971; the results of trap nesting are discussed on a later page.

Passaloecus armeniacae Cockerell and Fox. Moran, Aug. 1967, 2 ♀♀.

Passaloecus melanocrus Rohwer. Moran, July-Aug. 1967, 1 ♀, 1 ♂.

Subfamily Astatinae

Astata mexicana Cresson. Signal Mt., 7300-7700 feet, 28 July 1971, 5 ♂♂.

Astata nevadica Cresson. Signal Mt., 7300-7700 feet, 28 July 1971, 1 ♀.

Diploplectron brunneipes (Cresson). Pilgrim Creek, 2 Aug. 1964, 1 ♀; String Lake, 3 Aug. 1961, 1 ♀; Snake River, Elk, 14-26 July 1971, 1 ♀; Moran, 19 July - 17 Aug. 1967, 1 ♀, 2 ♂♂, 1 ♀, note no. 2163: taken from nest of *Philanthus pacificus*, as prey.

Diploplectron fossor Rohwer. Moran, 4-30 July 1961, 2 ♀♀, 2 ♂♂; Snake River, Elk, 9 Aug. 1967, 1 ♀, note no. 2144: taken from nest of *Philanthus pacificus*, as prey.

Diploplectron peglowi Krombein. Moran, 18 July 1967, 1 ♂.

Subfamily Larrinae

Nitelopterus laticeps Ashmead. Pacific Creek, 12 Aug. 1971, 1 ♀. This species has been studied by Powell (1967) under the name *N. californicus* (Ashmead).

Nitelopterus maurus Rohwer. Moran, July 16, 1961, 2 ♂♂. This record was originally entered under the name *N. cyanurus* (Rohwer), but I am informed by Joanne E. Slansky that they should be called *N. maurus*.

Subfamily Nyssoninae

Gorytes flagellatus Bohart. Snake River, Elk, 4-10 Aug. 1964, 1 ♂; Moran, 6 Aug. 1964, 1 ♀ on *Perideridia gairdneri*.

Gorytes provancheri Handlirsch. Signal Mt., 7300-7700 feet, 28 July 1971, 2 ♀♀.

Subfamily Philanthinae

Cerceris calcohorti Rohwer. Snake River, Elk, 29 July 1971, 2 ♂♂, note no. 2260: taken from nest of *Philanthus zebratus nitens* Banks, as prey.

II. Notes on a Ground-nesting Sphecid

Tachysphex aethiops Cresson

This is a common wasp in sandy soil along the Snake River, but I was able to report only one incomplete, parasitized nest in 1970. At 4:00 p.m. on 16 August 1971, I observed a female at a nest in firm, flat sand about 5 meters from the river (area MOR-A2 of the 1970 paper). The hole was open and there was a low, spreading mound of sand, 8 cm wide by 5 cm long, in front of the entrance. The female emerged from the burrow periodically and rose in the air to a height of 0.8 m, with her feet dangling, facing the burrow. The significance of this behavior was not apparent, as she soon began filling the burrow persistently, emerging again and again to scrape in sand from the entrance. I captured the wasp when the burrow was nearly filled and excavated the nest. It proved to be surprisingly shallow, an oblique burrow only 10 cm long terminating in a cell only 4 cm deep. This cell contained a paralyzed immature acridid grasshopper, *Trimerotropis* sp., probably *T. suffusa* Scudder [det. A. B. Gurney], bearing the egg of the wasp. Immediately beyond it, separated by only a thin barrier of soil, there was a second cell, containing an immature acridid of the same species, also bearing an egg. In both cases the egg was laid on the "throat" of the prey, with one end glued to the left front coxal membrane, the egg extending transversely over the right coxa, its posterior end free. Both cells obviously contained the full complement of prey, as the female was

making a final closure, and both grasshoppers exceeded the wasp in size (12 and 17 mm in length, as compared to 11 mm for the wasp). This compares favorably with data reported in 1970, for that nest also contained a single immature grasshopper somewhat larger than the wasp.

III. Results of Trap Nesting

During the first week in July 1971, I put out 300 trap nests, about half near the research station at Moran and half along Pilgrim Creek in Teton National Forest. Techniques were those described by Krombein (1967) in his well-known book on this subject; for terminology see his book, p. 18. Of the 300 nests, 200 were pieces of pine of the type used by Krombein, while 100 were sections of *Sambucus* stems cut to about the same length (15 cm), part of them bored and part with the pith intact. The *Sambucus* stems proved unsuccessful, only one being accepted by a wasp and 5 by bees. Of the 200 standard type, 65 were accepted by wasps in the course of the summer, 57 by bees. Those accepted by bees were turned over for study to Stephen L. Clement of the University of California at Davis; they are not considered here except in cases of supercedure involving a bee and a wasp. Trap nests were overwintered in Massachusetts, and all emergence occurred in April and May, 1972, there being but one generation per year of these species in Jackson Hole.

Although the percentage of acceptance was reasonably high, I was surprised to find that only four species of wasps (2 Eumenidae, 2 Sphecidae) were involved. Many other twig-nesting wasps are recorded from Jackson Hole, but evidently they did not lend themselves to these techniques. Although these four species occurred in much the same habitats, the kinds and numbers of parasites emerging from the nests were very different. *Symmorphus cristatus*, for example, was very heavily parasitized by the miltogrammine fly *Amobia distorta* Allen, and the other two mud-users had a low incidence of parasitism by *Amobia*. On the other hand, the resin-user *Passaloecus cuspidatus* appeared to be immune from attacks by *Amobia*, although it was the only one of the four to be parasitized by *Omalus* cuckoo wasps. Table I summarizes the results of the rearing of parasites.

Table 1. Parasites reared from nests of trap-nesting wasps.

Species of Wasp	No. Nests	Approx. No. Cells	No. Parasites Reared Amobia	Anthrax	Chrysididae
Symmorphus cristatus	25	75	36[1]	1	0
Ancistrocerus adiabatus	6	40	1[2]	1	2[3]
Trypoxylon aldrichi	14	50	2[1]	0	0
Passaloecus cuspidatus	20	120	0	1	6[4]

[1]*Amobia distorta* (Allen)
[2]*A. floridensis* (Townsend)
[3]*Chrysis caerulans* Fabr.
[4]*Omalus*, 3 species

Symmorphus cristatus (Saussure)

This was the most abundant wasp in trap nests and also the most heavily parasitized. Twenty-five trap nests were accepted, all at Moran. Most were associated with dead wood, either on the walls of log cabins or on stumps or standing or fallen dead pines and aspens. Only four of the nests were on live pines, one on a live willow. Traps accepted were from 0.3 to 2.5 meters high. Of the 25, 18 were in 4 mm borings, 7 in 6 mm borings. The number of cells per 13 cm boring was small compared to *Ancistrocerus adiabatus*: from 2 to 6, the majority having 3 or 4. Cell length varied from 8 to 24 mm (mean 15.5). Nest architecture was remarkably varied and is difficult to summarize. Closing plugs varied in thickness from 2 to 15 mm, most being 3 to 5 mm. As in Krombein's (1967) nests from New York and Virginia, all had an empty vestibular cell just inside the closing plug, and several of these cells were subdivided by partitions. Altogether the vestibular cells varied in length from 17 to 55 mm in length, with one exceptional one measuring only 5 mm. In addition to several having one or two partitions within the vestibular cell, two had barriers 3-4 mm thick (as compared to 1-2 mm thick partitions) essentially dividing the vestibular cell into two. For example, one nest had two cells at the end of the boring followed by two long, empty cells, 35 and 45 mm long, separated by a barrier 4 mm thick and closed on the outside by a plug 5 mm thick.

Intercalary cells, between filled cells, were also variable in occurrence and in length. In many cases they consisted of no more than two partitions separated by a space of only 1-3 mm; two nests had all or most of the cells separated by such double partitions, and one of these had one triple partition. One other nest had two distinct intercalary cells measuring 4 and 9 mm. The first cell was normally placed at the terminus of the boring, with no preliminary plug, but several had empty spaces preceding the first partition and cell, these spaces varying in length from 12 to 73 mm. A number of the more heavily parasitized nests had partitions that were partly destroyed by maggots when they were harvested; hence it is not possible to present accurate quantitative data on nest architecture.

Eggs were found in several cells, without exception suspended from the roof of the cell by a short filament, near the partition at the deep end of the cell. The prey are brought in after the egg is laid, from 3 to 10 (usually 4 to 6) being supplied per cell. Without exception the prey consisted of a single species of external, leaf-feeding beetle larvae (Chrysomelidae, Chrysomelinae [det. R. E. White]).

There were four instances of supercedure. In two cases *Symmorphus cristatus* had built 3-5 cells following 3-4 cells of the bee *Hoplitis* (*Formicapis*) *robusta* (Nylander).[2] In one case the bee superceded was an unidentified species of *Hylaeus*. In still another case a *Symmorphus* had filled a single cell deep in a boring and was

[2]Determination by Dr. G. C. Eickwort of Cornell University. Dr. Eickwort informs me that this species has usually been called *H. clypeata* (Sladen) and that *H. robusta* represents a new combination. Nothing has been published regarding the biology of this bee, but Stephen Clement and Richard Rust, of the University of California at Davis, are preparing a paper on this and several other species of *Hoplitis*.

superceded by the wasp *Passaloecus cuspidatus,* which prepared seven cells. In this instance the *Symmorphus* male that developed was eventually found dead in the cell, apparently unable to penetrate the resin partitions made by the *Passaloecus.*

No less than 14 of the 25 nests proved to have been parasitized by the miltogrammine fly *Amobia distorta* Allen [det. R. J. Gagne]. In all, 36 flies were reared from these 14 nests, a maximum of 6 flies emerging from each of 2 nests. Within the nests, the maggots moved freely from cell to cell, in some cases reducing the entire interior to loose bits of mud, pieces of prey, and maggots or puparia. A single bombyliid fly, *Anthrax irroratus* Say [det. L. V. Knutson], was reared from one nest.

In all, only 12 adult *Symmorphus cristatus* were reared from these nests, partly a result of the high incidence of parasitism. The remaining nests were presumed to belong to this species on the basis of the prey and, in two cases, on the basis of larvae preserved when the nest was opened.

Krombein (1967) has studied this species in some detail and has reviewed previous observations by Fye (1965). My own observations, so far as they go, are reasonably consistent with the results of those authors.

Ancistrocerus adiabatus (Saussure)

I obtained six nests of this species, five at Moran and one at Pilgrim Creek. These were in diverse situations: one on a tree root only 0.3 m high, two on dead trees about 1 m high, one on a cabin 1.3 m high, one on live willow, and one on live sagebrush 0.3-0.5 m high. Four of the nests were in 6 mm borings and had from 9 to 11 cells measuring from 8 to 22 mm in length; each had one or two empty vestibular cells measuring 10-15 mm in length. A fifth nest in a 6 mm boring had a single cell 15 mm long following several cells of a bee and followed by a long vestibular cell, 52 mm long. A single nest in a 4 mm boring had several cells (not counted) measuring 11-14 mm in length and followed by a vestibular cell 14 mm long. Closing plugs were of mud and measured 2-3 mm in thickness; partitions between cells were also of mud, but no more than 1 mm thick; none of the nests had preliminary plugs at the extremity of the boring. There were no intercalary cells or double partitions in these nests (in contrast to those of *Symmorphus*).

Provisioned cells were packed tightly with small caterpillars, 15-20 per cell. A sampling of these, 56 specimens from two separate nests, all proved to be *Coleotechnites* sp. (Gelechiidae) [det. D. M. Weisman]. Cocoons were whitish, very thin and delicate. The only case of supercedure was the one mentioned above, in which a single cell of *Ancistrocerus* followed several cells of a leafcutter bee (not reared, but probably *Hoplitis robusta*).

One nest was found to contain maggots in two cells; this nest later yielded one adult fly, *Amobia floridensis* (Townsend) [det. R. J. Gagne]. Another nest contained two brown, parchment-like cocoons; these later yielded cuckoo wasps, *Chrysis caerulans*

Fabricius. A third nest yielded a bombyliid fly, *Anthrax irroratus* Say [det. L. V. Knutson]. This fly emerged from a pupa that had worked its way out of the nest and into the rearing container; a second, dead pupa was inside the nest.

There are several published accounts of the nesting behavior of this widely distributed species, mostly under the name *A. tigris* (Saussure). My observations are consistent with Krombein's (1967) much more detailed studies. *Chrysis caerulans* has been reared from nests of this species on several occasions, and flies of the genera *Amobia* and *Anthrax* have often been reared from this and other species of the genus *Ancistrocerus*. Krombein found the prey to consist of microlepidopterous larvae of five families.

Trypoxylon aldrichi Sandhouse

Fourteen trap nests were accepted by wasps of this species, 10 at Pilgrim Creek and 4 at Moran. Five accepted 4 mm borings, 8 accepted 6 mm borings, and one nested in a 5 mm boring in a *Sambucus* stem. Traps accepted were from 0.3 to 1.2 meters high and were in a variety of situations: live alders, standing dead aspens, standing live or dead pines, and prostrate logs. The number of cells per 13 cm boring varied from 4 to 7, with two exceptions: one with 1 and one with 2 cells. The nest in the *Sambucus* stem had two cells in a boring only 4 cm long; both cells were 8 mm long. In 4 mm borings, cells varied in length from 8 to 20 mm (mean 13.5), while in 6 mm borings, cells varied in length from 7 to 20 mm (mean 12.0). An empty vestibular cell, 8-13 mm in length, was present in four nests. Empty intercalary cells, 2-5 mm in length, were found in two nests. Closing plugs varied in thickness from 2 to 7 mm, and in several cases were recessed slightly from the opening of the boring. Partitions between the cells were very thin; all partitions and plugs were of mud.

From 5 to 16 spiders were provided per cell, the larger number occurring in larger cells or when the spiders themselves were small in size. Spiders of four families were utilized, all of them web spinners, either orb webs, sheet webs, or the irregular webs of theridiids. The species are chiefly those occurring on tree trunks, in bushes, close to the ground, or under bark or stones. The following is a list of those spiders saved for identification and the numbers of each [determinations by H. W. Levi].

THERIDIIDAE

Achaearanea sp. 2 ♀♀
Chrysso nordica (C. and I.) 1 ♀
Steatoda sp. 2 juveniles
Theridion aurantium Emerton 24 ♀♀
T. differens Emerton 1 ♂

LINYPHIIDAE

Lepthyphantes spp. 7 ♀♀
Meioneta sp. 3 ♀♀
Pityohyphantes sp. 12 juveniles

Araneidae	
Genera and spp. ?	24 juveniles
Tetragnathidae	
Genus and sp. ?	1 juvenile

The egg of the wasp was found to be laid obliquely on the dorsum of the abdomen of one of the spiders deep in the cell. Twenty-nine *T. aldrichi* were eventually reared from eight of these nests, and although none were reared from the remaining six, I feel confident that all were nests of this species.

Only one instance of supercedure was found. In this case a bee (*Hoplitis robusta* Nylander) [det. G. C. Eickwort] had constructed four cells at the extremity of the boring, and the *Trypoxylon* had then constructed four more, a vestibular cell, and a closing plug.

I noted no maggots or puparia of parasitic flies when these nests were first examined, but one nest yielded two flies, *Amobia distorta* (Allen) [det. R. J. Gagne]. Two nests were, however, found to contain a small larva of a clerid beetle. In both nests there was evidence that the clerid had destroyed the egg or small larvae of the wasp; probably some feeding on the spiders also occurred. The clerids were not successfully reared to the adult stage.

Passaloecus cuspidatus Smith

Twenty trap nests were accepted by wasps of this species, 7 at Moran and 13 at Pilgrim Creek. These trap nests were from 0.3 to 1.5 m high and were in diverse situations: on our cabin at Moran, on pine and aspen stumps and logs, and attached to low branches of live pines. Twelve were in 4 mm borings, 8 in 6 mm borings. Brood cells in 4 mm borings averaged considerably longer than in 6 mm borings (mean 11 mm, range 7-17 mm, as compared to mean 8.5 mm, range 5-12 mm in 6 mm borings). The number of cells per 13 cm boring ranged from 2 to 16, all of those having more than 10 cells being in 6 mm borings. Partitions were of resin and were very thin, no more than 0.3 mm; in no case was there a partition at the extreme end of the boring. Closing plugs were from 2 to 5 mm thick and were also of clear resin except that several had dirt particles or wood chips mixed with the resin. As reported by Krombein (1967) from New York and Virginia, none of these nests had an empty intercalary cell, but all had empty vestibular cells; the latter varied in length from 12 to 58 mm, and one of them was divided in half by a thin partition.

Provisioned cells were packed tightly with aphids, usually wingless forms and often immatures. I counted the aphids in 14 cells and found the number to vary from 10 to 40 (mean 21), much of this variation the result of differences in the size of the aphids. The egg was found to be 1.3 mm long and to be laid on the venter of an aphid, one end attached just behind the hind coxae and the other end extending free, obliquely forward and upward.

In most of the nests, all the aphids were dark in color; I preserved 80 aphids from several cells of two nests, and all proved to be *Ptero-*

comma bicolor (Oestlund) [det. L. M. Russell]. However, two nests from Moran, collected on 9 and 13 August, were provisioned with aphids of paler coloration; I preserved 9 of these and all proved to be *Macrosiphum euphorbiae* (Thos.) [det. L. M. Russell]. Since there were over 2000 aphids in the 120 cells of this wasp and I preserved fewer than 100, I cannot be sure that other species of aphids were not involved. However, I noted none that were superficially different from these two species.

There were three instances of supercedure, in each case the *Passaloecus* usurping the nest of another wasp or bee. In one case *P. cuspidatus* built 6 cells following one cell of *Symmorphus cristatus;* in the other two cases *P. cuspidatus* built 4-10 cells following 3 cells of a bee. The bees were not reared successfully but were probably *Hoplitis robusta.*

Passaloecus appeared to be free from attacks of miltogrammine flies, possibly because of the nature of the partitions. One bombyliid fly, *Anthrax irroratus* Say [det. L. V. Knutson], was reared from a nest, but this was one of the nests containing three cells of a bee, and it was not determined in what cell that parasite had developed. An eight-celled nest yielded an ichneumon wasp, *Poemenia americana nebulosa* Habeck and Townes [det. H. K. Townes], as well as a chrysidid, *Omalus aeneus* Fabr. Both *O. aeneus* and *P. a. americana* (Cresson) have been reared from this host by Krombein (1967). I reared *Omalus aeneus* from one additional nest and also reared *O. cressoni* (Aaron) from one nest and *O. purpuratus* (Provancher) from two.

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ADDITIONAL RECORDS OF MUTILLID WASPS FROM THE NEVADA TEST SITE[1]

Dorald M. Allred[2]

From 1960 to 1964, more than 800 mutillids, mostly females, were collected in can pit traps during ecological studies by Brigham Young University at the Nevada Test Site (Allred, Beck, and Jorgensen, 1963). These were submitted to Dr. William E. Ferguson, San Jose State College, for study. I am indebted to him for making the identification of those specimens whose records are contained herein.

Inasmuch as the females of these insects have largely been unstudied and most species of mutillids have been described from the males, Ferguson spent part of the summer of 1964 at the test site in order to correlate the sexes of some species through specialized collecting. Specimens taken by him were principally males collected with light traps during August. In 1967 he published records of 31 species of mutillids of the test site, which included descriptions of 4 new to science, 2 new combinations, and 25 synonymies. Most of his published records were of males.

The records included here deal with females as well as some males which supplement those listed by Ferguson (1967). Inasmuch as the females are wingless and likely do not move for great distances, their occurrence in pit traps may be closely correlated with habitat and vegetation, whereas the males may fly for some distance before capture in light traps, and such correlation for them may be questionable. Notations of such habitat occurrence of these insects are included under the species listings.

The Nevada Test Site is situated approximately 70 miles northwest of Las Vegas in the southeastern part of Nye County, Nevada. It is typified by the Upper and Lower Sonoran life zones, representative of the cool and hot deserts of North America. The northern part of the test site occurs in the Great Basin, whereas the southern part is in the Mojave Desert.

In their description of the biotic communities of the Nevada Test Site, Allred, Beck, and Jorgensen (1963) delineated six major plant communities and assigned other less distinct areas to a "mixed" designation. The *Larrea divaricata-Franseria dumosa* community was designated as belonging to the Mojave Desert. Besides the predominant species for which the community was named, plants of 37 other species are common therein. The *Grayia spinosa-Lycium andersonii* and *Coleogyne ramosissima* plant communities, also of the Mojave Desert, each have 26 known species of common plants in their composition. *Atriplex confertifolia* and *Kochia americana* are the predominant plants in a community wherein only three other

[1]BYU-AEC Publication No. COO-1355-21.
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species are considered as common associates. The *Salsola kali* community is typical of disturbed areas and has as many as nine other species of common plant associates. The Pinyon-Juniper (*Pinus monophylla* and *Juniperus osteosperma*) community is characteristic of the mesas and higher foothill areas, particularly of the Great Basin region. Plants of fifteen other species are commonly associated with these Desert Woodland trees.

Additional Records

Acanthophotopsis falciformis falciformis Schuster. Ferguson (1967) listed records for six males collected in a light trap in August, and one in a pit trap in June. Additional record: Area 5—*Larrea divaricata-Franseria dumosa*, July, pit trap. Comment: Ferguson's (1967) records of this species were taken in the Mixed and *Larrea-Franseria* communities.

Acrophotopsis eurygnathus Schuster. Ferguson (1967) reported 19 males from the test site. Additional records: Area 5—*Lycium pallidum*, 4♂ July; 3♂ 2♀ June; *Larrea divaricata-Franseria dumost*, 1 ♂ 2 ♀ July, pit trap. Comments: Ferguson (1967) indicated the *Larrea-Franseria* community as the source of his specimens. His records also include the Mixed vegetative type. The *Lycium pallidum* is an additional habitat type for this species.

Chyphotes melaniceps Blake. This species has not been previously reported from the Nevada Test Site. Records (all males): Area 1—*Salsola kali*, 1 in June, pit trap; *Grayia spinosa-Lycium andersonii*, 1 in May, 1 in June, 2 in Aug., 2 in Sep., 2 in Oct., pit trap. Area 4—*Grayia spinosa-Lycium andersonii*, 1 in Aug., aerial net. Area 5—*Larrea divaricata-Franseria dumosa*, 6 in July, 1 in Sep., 1 in Oct., pit trap; *Lycium pallidum*, 2 in July, 7 in Aug., pit trap; 12 in July, incandescent-light trap. Area 6—*Atriplex confertifolia-Kochia americana*, 1 in Aug., pit trap; *Yucca brevifolia-Coleogyne ramosissima*, 9 in Aug., aerial net. Area C—Mixed vegetation, 1 in Aug., 2 in Sep., pit trap and aerial net, respectively. Area J—Mixed vegetation, 1 in Sep., pit trap. Comments: A variety of ecological types are occupied by this species. On the basis of seasonal occurrence, the *Grayia-Lycium* is the most commonly represented. However, greatest numbers were found in the *Lycium pallidum* areas.

Chyphotes petiolatus Fox. This species was not reported from the test site by Ferguson (1967). Records: (all males): Area 1—*Grayia spinosa-Lycium andersonii*, 5 in May, 6 in June, 3 in July, 1 in Aug., 2 in Sep., pit trap; 1 in Mar., aerial net; *Salsola kali*, 1 in May, pit trap. Area 5—*Larrea divaricata-Franseria dumosa*, 1 in Apr., 5 in June, 2 in July, 2 in Aug., pit trap; *Lycium pallidum*, 1 in Apr., 5 in May, 4 in June, 4 in July, 4 in Aug., 2 in Sep., pit trap. Area 10—*Coleogyne ramosissima*, 2 in June, pit trap. Area CB—Mixed vegetation, 1 in Sep., pit trap. Comments: This species occupies a variety of habitats. Seasonally and in abundance it is most common in the *Lycium pallidum* and *Grayia-Lycium* communities.

Dasymutilla gloriosa (Saussure). Ferguson (1967) reported three females taken from the test site. ADDITIONAL RECORDS: Area 1—*Salsola kali*, ♀, June, pit trap. Area 4—*Grayia spinosa-Lycium andersonii*, ♀, Sep., aerial net. Area 400—Mixed vegetation, ♀, July, by hand. Area C—Mixed vegetation, ♀, July, pit trap.

Dasymutilla klugii (Gray). Ferguson (1967) did not report this species from the test site. RECORD: Area 5—*Larrea divaricata-Franseria dumosa*, ♂, July, aerial net.

Dasymutilla satanas Mickel. Ferguson (1967) reported 24 females from the test site. ADDITIONAL RECORDS: Area 4—*Grayia spinosa-Lycium andersonii*, 2 ♀ July, ♀ Aug., 2 ♀ Sep., pit trap; ♀ Aug., aerial net. Area 5—*Larrea divaricata-Franseria dumosa*, ♂ 3 ♀ July; *Lycium pallidum*, 4 ♀ July, 3 ♀ Aug., ♀ Sep., pit trap. Area 10—*Coleogyne ramosissima*, ♀ Aug.; *Salsola kali*, ♀ Aug., pit trap. Area C—Mixed vegetation, ♀ June, pit trap. COMMENTS: Ferguson's (1967) records were related to Mixed and *Larrea-Franseria* communities. Additional records show a variety of habitats for this species. Seasonally and in numbers it is apparently most common in the *Lycium pallidum* and *Grayia-Lycium* communities.

Odontophotopsis mamata Schuster. Ferguson (1967) reported 100 specimens from the test site. ADDITIONAL RECORDS (all males): Area 1—*Grayia spinosa-Lycium andersonii*, 1 in July, 2 in Aug., pit trap. Area 5—*Lycium pallidum*, 1 in June, 1 in July, 21 in Aug., 1 in Sep., pit trap; 4 in July, incandescent-light trap; *Larrea divaricata-Franseria dumosa*, 3 in July, 3 in Aug., pit trap. Area 6—*Yucca brevifolia-Coleogyne ramosissima*, 12 in Aug., aerial net. Area C—Mixed vegetation, 1 in Aug., aerial net. Area J—Mixed vegetation, 1 in Aug., pit trap. COMMENTS: This species occurs in a variety of habitats but is probably most common in the *Lycium pallidum* community. Ferguson's (1967) records were from only the Mixed community type.

Odontophotopsis setifera Schuster. Ferguson (1967) indicated one specimen from the test site. ADDITIONAL RECORD: Area 5—*Lycium pallidum*, ♂ July, incandescent-light trap.

Sphaeropthalma angulifera Schuster. Ferguson (1967) reported seven specimens from the test site. ADDITIONAL RECORDS: Area 1—*Grayia spinosa-Lycium andersonii*, 2 ♂ June, ♂ July, ♂ Sept.; *Salsola kali*, ♂ June, pit trap. Area 5—*Larrea divaricata-Franseria dumosa*, 2 ♀ May, 3 ♀ June, 3 ♀ July, pit trap. Area J—Mixed vegetation, ♀ June, pit trap. COMMENTS: Ferguson's (1967) records were taken in Mixed vegetation and *Coleogyne* communities. He indicated that this species does not occur at lower elevations. However, additional records show it to occur in several habitats, primarily in the *Larrea-Franseria* and *Grayia-Lycium* communities.

Sphaeropthalma blakeii (Fox). Ferguson (1967) listed three specimens from the test site. ADDITIONAL RECORDS (both males): 1 in June, 1 in Oct., pit trap.

Sphaeropthalma sonora Schuster. Ferguson (1967) recorded 90 specimens from the test site. ADDITIONAL RECORDS (all males): Area

1—*Grayia spinosa-Lycium andersonii*, 1 in June, 1 in July, 1 in Aug., pit trap. Area 5—*Larrea divaricata-Franseria dumosa*, 12 in July, 4 in Aug., pit trap; 6 in Aug., aerial net; *Lycium pallidum*, 2 in July, 6 in Aug., pit trap; 15 in July, incandescent-light trap; 18 in June, 2 in July, black-light trap. Area 6—*Yucca brevifolia-Coleogyne ramosissima*, 1 in Aug., aerial net. Area 10—*Grayia spinosa-Lycium andersonii*, 3 in July, pit trap. Area CB—Mixed vegetation, 1 in Sep., aerial net. COMMENTS: Ferguson (1967) indicated that this species is common at lower elevations below the Pinyon-Juniper and *Coleogyne* communities. Additional records show it to be most common seasonally and in numbers in the *Lycium pallidum* and *Larrea-Franseria* communities.

Sphaeropthalma unicolor (Cresson). Ferguson (1967) listed 76 females and 53 males from the test site. ADDITIONAL RECORDS: Area 1—*Grayia spinosa-Lycium andersonii*, 10 ♀ Apr., 23 ♀ May, 12 ♀ June, 11 ♀ July, ♂ 5 ♀ Aug., ♂ 4 ♀ Sep., 3 ♀ Oct., ♀ Nov., pit trap; ♀ May, aerial net; *Salsola kali*, 2 ♀ June, pit trap. Area 4—*Grayia spinosa-Lycium andersonii*, ♂ Aug., aerial net. Area 5—*Larrea divaricata-Franseria dumosa*, ♀ June, ♀ Aug., pit trap. Area 10—*Coleogyne ramosissima*, ♂ July, pit trap. Area J—Mixed vegetation, 2 ♀ Apr., 2 ♀ May, ♂ 3 ♀ Aug., pit trap. COMMENTS: This species was taken by Ferguson (1967) in essentially all communities from the valley floors to the tops of the mesas. Additional records show it to be most common seasonally and in numbers in the *Grayia-Lycium* community.

SUMMARY

Ferguson (1967) listed 31 species of mutillids from the Nevada Test Site. Three additional records are herein recorded—*Chyphotes melaniceps*, *C. petiolatus*, and *Dasymutilla klugii*.

On the basis of numbers collected, the following species are considered as rare at the test site (fewer than 10 specimens collected, as indicated by the numbers in parentheses):

Dasymutilla klugii	(1)	*Dasymutilla gloriosa*	(4)
Dasymutilla paenulata	(1)	*Dilophotopsis concolor*	(4)
Sphaeropthalma helicaon	(1)	*Sphaeropthalma blakeii*	(5)
Odontophotopsis setifera	(2)	*Sphaeropthalma ferruginea*	(6)
Sphaeropthalma macswaini	(3)	*Sphaeropthalma pallida*	(7)
Sphaeropthalma parapenalis	(3)	*Acanthophotopsis falciformis*	(8)

Considered as relatively abundant at the test site (over 100 specimens collected, as indicated by the numbers in parentheses) are the following species:

Sphaeropthalma unicolor	(216)	*Sphaeropthalma sonora*	(164)

Mutillids of the species *Chyphotes melaniceps* were the most widespread ecologically, whereas those belonging to *Sphaeropthalma unicolor* were the most widespread seasonally (Table 1). The greatest varieties of species were found in the Mixed, *Larrea-Franseria*, and *Grayia-Lycium* communities, in that order, and the fewest in

the *Atriplex-Kochia* (Table 2). The greatest number of species was taken during July, and the fewest in March and November; none were found from December through February (Table 3). Greatest

TABLE 1. Summary of ecological and seasonal distribution of some mutillids at the Nevada Test Site.

Species	No. communities in which found	No. months collected
Chyphotes melaniceps	8	6
Chyphotes petiolatus	6	7
Dasymutilla satanas	6	4
Odontophotopsis mamata	6	4
Sphaeropthalma sonora	5	4
Sphaeropthalma unicolor	5	9
Sphaeropthalma angulifera	4	4
Dasymutilla gloriosa	3	3
Acrophotopsis eurygnathus	2	2
Acanthophotopsis falciformis	1	1
Dasymutilla klugii	1	1
Odontophotopsis setifera	1	1
Sphaeropthalma blakeii	1	1

TABLE 2. Number of species and relative abundance of individual mutillids in seven vegetative types at the Nevada Test Site.

Vegetative type	Number of species	Individual abundance factor*
Mixed	26	1.6
Larrea divaricata-Franseria dumosa	20	11.8
Grayia spinosa-Lycium andersonii	14	6.5
Lycium pallidum	10	19.3
Coleogyne ramosissima	9	2.4
Salsola kali	6	1.0
Atriplex confertifolia-Kochia americana	3	1.4

*Compared to 1 as representative of the fewest collected; adjusted to number of trap nights and collection attempts.

TABLE 3. Number of species and abundance of individuals collected during months of mutillid activity at the Nevada Test Site.

Month	Number species	Abundance[1] Actual numbers	Ratio factor[2]
March	2	2	1.0
April	3	17	5.7
May	6	46	7.7
June	14	96	6.9
July	18	196	10.9
August	14	145	10.4
September	12	53	4.4
October	6	21	3.5
November	2	2	1.0

[1]Based on equal collecting efforts for each month over a three-year period, 1959-1962.
[2]The number of individuals divided by the number of species. The higher the factor, the greater the relative abundance.

numbers of individuals were taken in July, although in consideration of the number of species represented, populations were not significantly different between July and August (Table 3). On this latter basis, a decline in the expected increase in relative populations in relationship to numbers of species was noted for June (Figure 1).

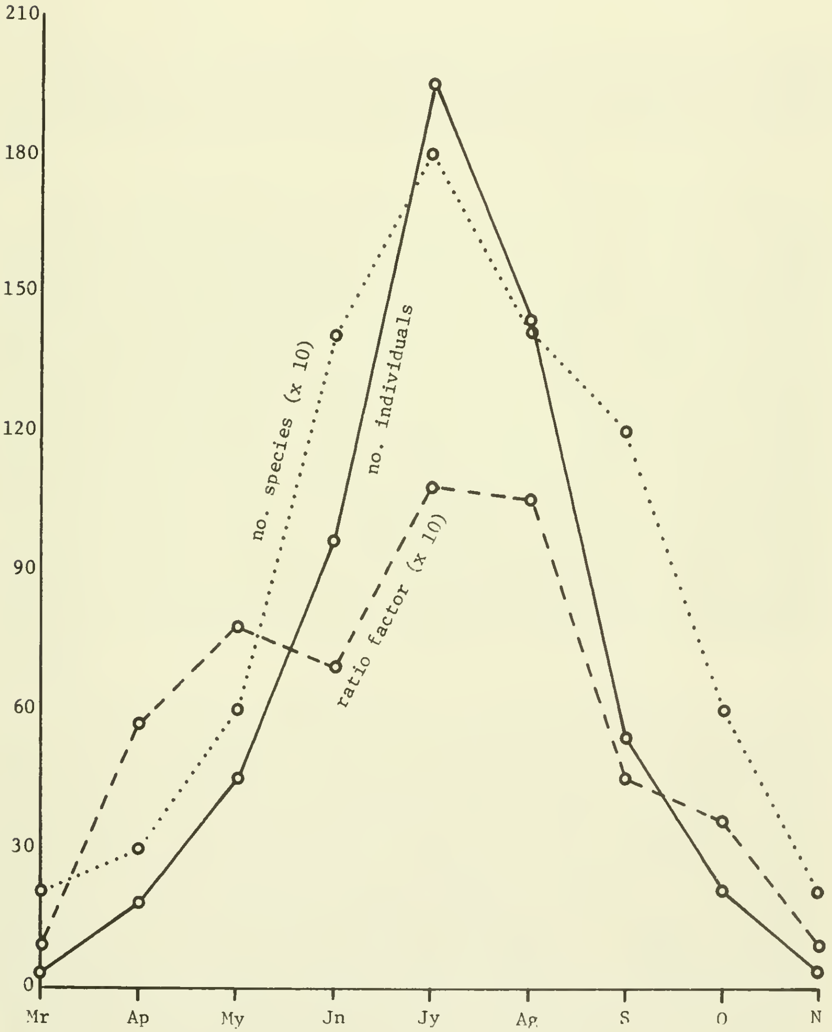

Fig. 1. Seasonal trend of numbers of individual mutillids, numbers of species represented, and the ratio factor (number of individuals divided by number of species represented). The number of species and ratio factor were multiplied by 10 to correlate more closely in degree for comparison with population number trends.

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THE EFFECTS OF SOIL TEXTURE ON SPECIES DIVERSITY IN AN ARID GRASSLAND OF THE EASTERN GREAT BASIN

John W. Wyckoff[1]

Abstract.— A primary factor limiting plant species diversity in desert grasslands seems to be soil texture. Loamy soils consistently support more species than do adjacent sands. This is probably related to the increased micro-environmental differences associated with heavy textured soils. Such soils would be expected to have more micro-topographic and soil moisture variations than sandy soils.

The grassy communities of the Great Salt Lake State Park, situated on the northern end of Antelope Island of the Great Salt Lake, Utah, were intensively studied during the period 14 June to 3 September 1971. This study was part of a larger project funded by the Student Originated Studies Program of the National Science Foundation (Carter *et al.*, 1971). The major aim of my study was to evaluate the relationships of vascular plant diversity to soil texture and micro-environmental variation within the arid grasslands of the park.

The fact that soil texture is an important ecological factor controlling plant populations is well known (Black, 1968). Soil particles regulate the flow of moisture, retention of nutrients, and movement of air within a given soil (Russell, 1957). Locally, extensive work has been done to document characteristics of soils of the Great Salt Lake-Wasatch Front region (Erickson, 1968; Jennings, 1946; Thorne, 1968). Other research in this general geographic area has shown definite correlations between composition of grassland communities and edaphic conditions (Kleiner, 1966 and 1968; Ludwig, 1965 and 1969).

The area under consideration is in the northeastern part of the Great Basin, approximately 30 mi. northwest of Salt Lake City, Utah. The vegetation of the park is dominated by grassland species typical of this region. The communities studied have been grazed by livestock until the recent past and support both native and introduced plant species (Table 1). Soils in the park ranged from sand, at locations near the lake, to sandy loam in areas farther from the shoreline. Since most of the precipitation in this part of the Great Basin is restricted to the winter months, most water available to vegetation is present for only a short time in the spring. The only other sources of water during the year are small, infrequent storms which occur during the drier summer months. Total precipitation annually averages approximately 10 in. Therefore water is one of the primary limiting factors for plants in this area, and competition for water may have important effects on the abundance and distribution of most plant species.

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Table 1. Species encountered in the grasslands of Great Salt Lake State Park showing average quadrat frequency expressed as a percentage of the total within the 15 sections of each 16.2 hectare plot.

Species	Plot 1	Plot 2	Plot 3
Agropyron spicatum	0.3	1.0	41.0
Aristida longiseta	13.8	50.5	29.3
Artemisia tridentata	5.0	1.3	0.3
Astragalus utahensis	0.3	0.3	0.3
Bromus tectorum	85.0	99.3	100.0
Castilleja angustifolia	0.3	0.3	0.3
Chrysothamnus nauseosus	1.5	0.3	0.3
Chrysothamnus viscidiflorus	7.3	0.3	0.3
Cleome lutea	0.5	1.0	0.3
Cryptantha parva	0.3	0.3	0.3
Cymopteris longipes	0.3	0.3	10.5
Distichlis stricta	14.0	0.3	0.3
Erigeron englemani	0.3	0.3	3.8
Erodium cicutarium	38.5	91.5	20.8
Festuca myoros	0.3	2.5	0.3
Guterrezia sarothrae	2.8	0.3	0.3
Hordeum jubatum	2.8	0.3	0.3
Lactuca scariola	0.3	0.3	0.3
Lomatium grayii	0.3	0.3	5.5
Oryzopsis hymenoides	3.0	1.0	0.3
Phlox longifolia	8.0	3.0	6.8
Poa sandbergii	15.3	30.3	54.3
Salsola kali	0.5	0.3	0.3
Sisymbrium altissimum	0.3	0.3	0.3
Sitanion jubatum	0.5	0.3	0.3
Sphaeralcea coccinea	21.3	2.0	2.0
Sporobolus airoides	6.8	0.3	0.3
Sporobolus cryptandrus	8.8	18.3	4.8
Stipa comata	3.5	5.5	0.3
Zigadenus paniculata	0.8	0.3	0.3
Percent exotics	51.3	61.4	42.7
Percent native	48.7	38.6	57.3
Average Plant Diversity/.007 h	3.5	4.2	3.9

Methods

Three areas in the park were selected for vegetational studies. The first was comprised primarily of introduced species, the second was intermediate with approximately equal numbers of introduced and native species, and the third was dominated by native species. Each area encompassed 16.2 hectares (40 acres) and was subsampled by fifteen 0.007 hectare (1/60 acre) circular sections. Within each of these sections, the vegetation was sampled with 25 quadrats. Each quadrat had an area of 0.25 m^2 and was subdivided into 4 units (quartiles) of equal size. At each sampling point the presence or absence of individual plant species was noted for each quartile. From these quadrat analyses a frequency of occurrence was established for each plant species present.

Soil and surface environmental analyses were made within each of the 0.007 hectare sections. Soil data taken included particle size, pH, free carbonates, and salinity. Soil particle size was determined using Bouyoucos's (1962) method, pH was obtained with a dual

glass electrode meter (Leeds and Northrup) on a soil paste, and presence of free carbonates was determined by an effervescence test using a 10 percent HCL solution. Salinity was evaluated by conductivity of soil paste using a Wheatstone Bridge and soil cup electrode. Surface environmental variables such as surface rock, living cover, and bare soil were determined quantitatively by an ocular estimation technique (Warner and Harper, 1972). Average values for the several variables are reported for the three major study areas in Table 2.

Using MacArthur and Wilson's (1967) diversity index

$$\text{Diversity index} = \frac{1}{\Sigma P^2_{a-z}}$$

where $$P_a = \frac{\text{frequency of species a}}{\Sigma \text{ frequency of species a-z}}$$

it was possible to calculate a workable diversity index for each of the study sections. The minimum diversity for this index is 1.0 and the magnitude of the index increases as the number of species and the uniformity of their frequency values increase.

Results and Discussion

The influence of various environmental parameters on plant species diversity was evaluated by stepwise multiple regression (Dixon, 1969). Results of the computer analysis give an indication of the relative influence of each environmental variable on vegetational diversity (Table 3). It is apparent that of those environmental variables studied, soil texture has the most influence upon plant diversity. The relationship between soil texture and plant diversity is graphically shown in Fig. 1. This is probably due to a greater degree of microenvironmental diversity on more consolidated soils. Increased diversity might be related, for example, to more small scale runoff and accumulation of water on the heavier textured soils. Additionally, in an arid environment one might expect "effective"

Table 2. Average values for environmental variables/16.2 hectare plot.

	Plot 1	Plot 2	Plot 3
Percent sand	83.4	62.4	63.4
Percent fines	16.6	37.6	36.6
pH	8.34	7.53	7.34
Conductivity*	2235	1391	dna†
Percent surface rock	1.1	4.9	31.3
Percent living cover	73.8	64.8	52.4
Percent surface litter	15.1	16.8	9.0
Percent bare soil	15.6	17.0	14.4
Carbonates (No. of 0.007 hectare sections found in)	13	7	9

*Conductivity in ohms is measurement of salinity
†dna = data not available

precipitation (i.e., precipitation which can be utilized by plants) to be lower on heavier textured soils due to less deep infiltration and correspondingly larger losses via evaporation as opposed to trans-

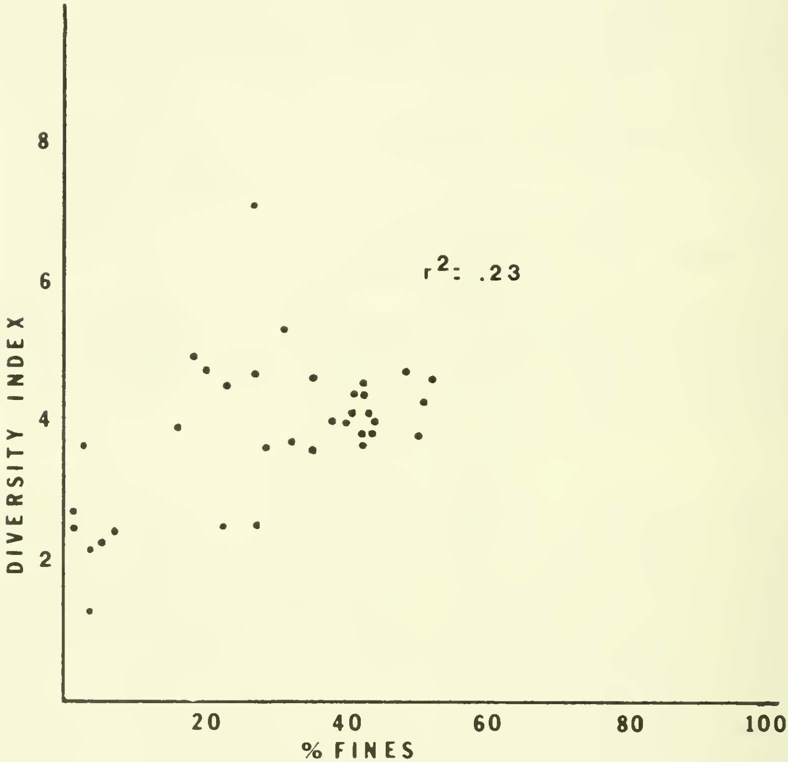

Fig. 1. Graphical portrayal of the relationship between plant diversity and percentage of soil particles classified as fines (percent silt + percent clay). Diversity indices are calculated using MacArthur and Wilson's (1967) index as described in text.

Table 3. Results of stepwise multiple regression analysis of environmental variables affecting plant species diversity. Variables are shown in the order in which they entered the analysis.

Variable	Influence on Diversity	R-value	R-square value	Increase in R-square
Soil fines	+	.4796	.2301	.2301
Surface litter	+	.5383	.2898	.0597
Living cover	—	.5743	.3298	.0400
Free carbonates	—	.6231	.3882	.0584
Soil sand	—	.6440	.4148	.0266
Bare soil	+	.6532	.4267	.0119
ph	—	.6552	.4292	.0025
Salinity	—	.6580	.4330	.0037

piration (Black, 1968). The combined effects of heterogeneous distribution of water and greater aridity of heavy textured soils per unit precipitation would result in more habitat diversity (niches) and a more sparse vegetation with the likelihood of reduced competition between individuals. Both conditions could lead to enhanced diversity. Data supportive of these hypotheses can also be extracted from Ludwig's (1969) study of several grassland communities in northern Utah (Table 4).

TABLE 4. Community data for grasslands in northern Utah (Ludwig, 1969).

Community type	Average no. spp./.025 acre	Average no. spp./quad	Average percent fines
Agropyron spicatum	26.28	5.80	69
Stipa comata	13.74	4.44	36
Sporobolus cryptandrus	10.29	4.61	30
Oryzopsis hymenoides	9.67	3.12	—

CONCLUSIONS

In Great Salt Lake State Park, sandy sites consistently have lower diversity than loamy sites. These data suggest that much of the vegetational diversity within the community is dependent upon edaphic factors; this finding is probably related to the uniform environment of sandy areas. On such sites, the best adapted species could invade and completely dominate, whereas in areas which foster microenvironmental diversity (i.e., heavier textured soils, which have more small scale runoff and therefore small adjacent areas with very different amounts of "effective" precipitation) any one species would find it difficult to dominate the entire area.

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NEW SYNONYMY IN AMERICAN BARK BEETLES (SCOLYTIDAE: COLEOPTERA). PART III[1]

Stephen L. Wood[2]

Abstract.— New synonymy affecting North and Central American Scolytidae is proposed as follows: *Araptus* Eichhoff (=*Neodryocoetes* Eggers, *Thamnophthorus* Schedl, *Sphenoceros* Schedl), *Coccotrypes* Eichhoff (=*Poecilips* Schaufuss), *Gnathotrichus* Eichhoff (=*Ancyloderes* Blackman, *Prognathotrichus* Bright), *Gnathotrupes* Schedl (=*Gnathotrypanus* Wood), *Araptus hymenaeae* (Eggers), n. comb., (=*Neodryocoetes insularis* Eggers, *Neodryocoetes caribaeus* Blackman, *Neodryocoetes guianae* Blackman, *Neodryocoetes hoodi* Blackman), *Araptus laevigatus* (Eggers), n. comb. (=*Neopityophthorus insularis* Eggers, *Neodryocoetes guadeloupensis* Schedl), *Araptus macer* Bright, n. comb. (=*Neodryocoetes tuberculatus* Bright), *Araptus politus* (Blandford), n. comb. (=*Neodryocoetes hubbardi* Blackman), *Araptus tabogae* (Blackman), n. comb. (=*Neodryocoetes vinealis* Bright), *Cnesinus elegantis* Wood (=*Cnesinus zapotecus* Bright), *Coccotrypes advena* Blandford (=*Thamnurgides persicae* Hopkins), *Corthylocurus barbatus* (Blandford) (=*Corthylocurus cincinnatus* Bright), *Corthylocurus mexicanus* (Schedl) (=*Corthylus anomalus* Bright), *Corthylus mexicanus* Schedl (=*Corthylus glabinus* Bright), *Crypturgus pusillus* (Gyllenhal) (=*Crypturgus atomus* LeConte), *Dendrocranulus carbonarius* (Ferrari) (=*Xylocleptes floridensis* Hopkins, *Xylocleptes anonae* Hopkins), *Dendrocranulus cucurbitae* (LeConte) (=*Xylocleptes californicus* Hopkins, *Xylocleptes venturina* Hopkins, *Xylocleptes punctatus* Hopkins), *Dendrocranulus macilentus* (Blandford) (=*Dendrocranulus grossopunctatus* Schedl), *Hylastes salebrosus* Eichhoff (=*Hylastes scobinosus* Eichhoff), *Hypothenemus seriatus* (Eichhoff) (=*Stephanoderes pulverulentus* Eichhoff), *Ips spinifer* (Eichhoff) (=*Orthotomicus sabinianae* Hopping), *Leperisinus aculeatus* (Say) (=*Hylesinus imperialis* Eichhoff), *Micracis lignator* Blackman (=*Micracis truncatus* Wood), *Micracis swainei* Blackman (=*Micracis photophilus* Wood), *Micracis suturalis* LeConte (=*Micracis meridianus* Blackman), *Monarthrum querneus* Wood (=*Monarthrum bifidus* Bright), *Orthotomicus caelatus* Eichhoff (=*Xyleborus vicinus* LeConte, *Xyleborus punctipennis* LeConte), *Coccotrypes indicus* (Eggers) (=*Xyleborus conspeciens* Schedl, *Coccotrypes insularis* Eggers, *Poecilips eggersi* Schedl), *Phloeoborus asper* Erichson (=*Phloeoborus ovatus* Chapuis, *Phloeoborus rugatus* Blandford), *Phloeoborus rudis* Erichson (=*Phloeoborus elongatus* Chapuis, *Phloeoborus rugipennis* Eggers), *Phloeotribus armatus* Blandford (=*Phloeotribus mixtecus* Bright), *Phloeotribus demessus* Blandford (=*Phloeotribus tuberculatus* Eggers), *Phloeotribus pilula* (Erichson) (=*Phloeotribus obliquus* Chapuis, *Phloeotribus manni* Blackman), *Phloeotribus setulosus* Eichhoff (=*Phloeotribus asperatus* Blandford), *Pityoborus frontalis* Wood (=*Pityoborus severus* Bright), *Pityoborus secundus* Blackman (=*Pityoborus tertius* Blackman, *Pityoborus immitus* Bright, *Pityoborus intonsus* Wood, *Pityoborus ramosus* Bright), *Pycnarthrum hispidum* (Ferrari) (=*Nemobius lambottei* Chapuis, *Pycnarthrum gracile* Eichhoff, *Pycnarthrum quadraticolle* Eichhoff, *Pycnarthrum transversum* Blandford, *Pycnarthrum reimoseri* Schedl, *Pycnarthrum reticulatus* Schedl), *Pseudopityophthorus declivis* Wood (=*Pseudopityophthorus truncatus* Bright, *Pseudopityophthorus curtus* Bright), *Pseudopityophthorus hondurensis* Wood (=*Pseudopityophthorus montanus* Bright), *Pseudopityophthorus micans* Wood (=*Pseudopityophthorus squamosus* Bright), *Pseudopityophthorus opacicollis* Blackman (=*Pseudopityophthorus aesculinus* Bright), *Pseudopityophthorus pruinosus* (Eichhoff) (=*Pseudopityophthorus pulvereus* Blackman, *Pseudopityophthorus tropicalis* Wood, *Pseudopityophthorus convexus* Bright), *Pseudopityophthorus singularis* Wood (=*Pseudopityophthorus acuminatus* Bright), *Pseudopityophthorus tennis* Wood (=*Pseudopityophthorus hirsutus* Bright), *Stenocleptus sulcatus* (Bruck) (=*Stenocleptus ceanothi* Blackman,

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Stenocleptus rhois Blackman), *Thysanoes texanus* Blackman (=*Thysanoes vachelliae* Blackman, *Thysanoes ratamae* Blackman), *Trypophloeus striatulus* (Mannerheim) (=*Trypophloeus nitidus* Swaine), *Xyleborus capucinus* Eichhoff (=*Xyleborus rufithorax* Eichhoff), *Xyleborus pubescens* Zimmermann (=*Xyleborus pini* Say of Eichhoff), *Xylosandrus curtulus* Eichhoff (=*Xyleborus biseriatus* Schedl). *Carphotoreus*, n. gen., is described for *Chaetophloeus alni* Bright. *Coccotrypes sannio* (Schaufuss) is treated as a taxon distinct from *Coccotrypes advena* Blandford; and *Gnathotrichus consentaneus* Blandford is a valid species distinct from *Gnathotrichus sulcatus* LeConte. *Gnathotrichus bituberculatus* Blandford and all described South American species of *Gnathotrichus* are transferred to *Gnathotrupes*.

In the process of writing a taxonomic monograph of the Scolytidae of North and Central America, the unpublished synonymy summarized in the above abstract and treated on the following pages was encountered. In order to stabilize nomenclature and fix many established names, several lectotypes are designated and the resulting new synonymies are reported. Wherever possible the traditional usage has been preserved through lectotype designation. In several instances, however, established names are junior synonyms and cannot be conserved. In my opinion none of the junior synonyms affected by this action are sufficiently important to warrant special action to conserve them. The basis on which the synonymy is established is cited for each name treated.

Araptus Eichhoff

Araptus Eichhoff, 1878, Mem. Soc. Roy. Sci. Liége (2)8:305 (Type-species: *Araptus rufopalliatus* Eichhoff, monobasic)

Neodryocoetes Eggers, 1933, Mém. Trav. Lab. d'Ent. Mus. Nat. d'Hist. Nat., Paris 1(1):9 (Type-species: *Neodryocoetes hymenaeae Eggers*, monobasic). New synonymy

Thamnophthorus Schedl, 1938, Archiv Naturgesch. 7:174 (Type-species: *Thamnophthorus volastos* Schedl, subsequent designation by Blackman, 1942, Proc. U.S. Nat. Mus. 92:178). New synonymy

Sphenoceros Schedl, 1939, Mitt. Münchner Ent. Ges. 29:565 (Type-species: *Sphenoceros limax* Schedl, monobasic). New synonymy

The unique female holotype of *Araptus rufopalliatus* Eichhoff in the Institut Royal des Sciences Naturelles de Belgique, Brussels, lacks antennae and legs. The frons of this specimen has unusual sculpture and the epistoma is deeply emarginate; consequently, the phylogenetic position of this genus remained a mystery until a series of specimens identical to the type was collected at La Carbonera experimental forest, 50 km NW Merida, Merida, Venezuela, 16-IX-1969, at 2500 m, No. 21b, from *Nectandra* sp., by myself. The antennae, legs, other anatomical features, and the habits clearly indicate that this species is congeneric with *Neodryocoetes hymenaeae* Eggers. *Neodryocoetes* Eggers, therefore, must be placed in synonymy as indicated above.

In a review of the Central American species of *Araptus* it was noted that the antennal and other features used to characterize *Thamnophthorus* Schedl and *Sphenoceros* Schedl are not consistent and intergrade completely with those of various other species groups of *Araptus*. The species formerly assigned to *Sphenoceros* are phloe-

ophagous, not xylomycetophagous as assumed by Schedl. The names *Thamnophthorus* Schedl and *Sphenoceros* Schedl, consequently, are placed in synonymy under *Araptus*.

Carphotoreus, n. gen.

This genus superficially resembles certain *Chaetophloeus* species, but it is distinguished by the 6-segmented antennal funicle, by the more widely distributed crenulations on the basal margins of the elytra, by the absence of submarginal crenulations on the elytral bases, by the visible scutellum, by the different arrangement and type of pronotal asperities, and by other characters.

Description.— Length 1.5-1.6 mm, 2.14 times as long as wide.

Frons sexually dimorphic, moderately concave in male, flattened or convex in female; eye elongate-oval, entire; scape moderately long, funicle 6-segmented, club flattened, almost symmetrical, three nonseptate sutures indicated. Pronotum wider than long, anterolateral areas with a few asperities. Scutellum small, visible. Elytra suturally emarginate at base, a row of marginal crenulations at base, submarginal crenulations entirely absent; striate; declivity simple. Anterior coxae moderately separated. Third tarsal segments slender.

Type-species.— *Chaetophloeus alni* Bright.

This genus belongs to the Hylesinini and is tentatively placed near *Alniphagus* Swaine, although the relationship is not close.

Coccotrypes Eichhoff

Coccotrypes Eichhoff, 1878, Mém. Soc. Roy. Sci. Liége (2)8:308 (Type species: *Bostrichus dactyliperda* Fabricius, subsequent designation by Hopkins, 1914, Proc. U.S. Nat. Mus. 48:118)

Poecilips Schaufuss, 1897, Berliner Ent. Zeitschr. 42:110 (Type-species: *Poecilips sannio* Schaufuss, monobasic). New synonymy

This large diverse genus has been divided into *Coccotrypes* Eichhoff and *Poecilips* Schaufuss on the basis of pronotal structure and armature, and on habits. In a review of species assigned to these generic names, however, there seems to be considerable confusion. In *Coccotrypes* the pronotum should be strongly convex, with the anterior slope asperate, and they are spermophagous. In *Poecilips* the pronotum should be more weakly convex, with the anterior slope unarmed, and most species are supposed to be phloeophagous. Actually, there is a complete transition in characters within the group from a strongly to a weakly convex pronotum, and from a coarsely asperate to smooth anterior slope of the pronotum; in addition, many species may breed successfully in either fruit (seeds) or phloem. *Coccotrypes indicus* (Eggers) is an example where each of at least two different authors have simultaneously recognized one synonym as a valid species of *Coccotrypes* and another synonym as a valid species of *Poecilips*, depending on the geographic area of origin of the specimens examined. Under the circumstances it appears im-

possible to recognize more than one genus. A majority of species included in the group are intermediate in characters expressed, although the more familiar, economically important species represent the extremes.

Gnathotrichus Eichhoff

Gnathotrichus Eichhoff, 1869, Berliner Ent. Zeitschr. 12:75 (Type-species: *Gnathotrichus corthyloides* Eichhoff = *Tomicus materiarius* Fitch, monobasic)

Ancyloderes Blackman, 1938, Proc. Ent. Soc. Washington 40:20 (Type-species: *Cryphalus pilosus* LeConte, original designation). New synonymy

Prognathotrichus Bright, 1972, Canadian Ent. 104:1678 (Type-species: *Prognathotrichus primus* Bright, original designation). New synonymy

The type-species of *Ancyloderes* Blackman, *pilosus* (LeConte), is known only from collections at light. Its relationship to other species, for this reason, has been doubtful. Recently, several allied species have been described from *Quercus* in Mexico, indicating a clear relationship to *Gnathotrichus*. These species include *obscurus* Wood, *dentatus* Wood, *nimifrons* Wood, and *primus* (Bright). These species completely bridge the gap between *Ancyloderes* and *Gnathotrichus*. Since *primus* falls into the same species group with *pilosus*, *Paragnathotrichus* Bright and *Ancyloderes* must be placed in synonymy under *Gnathotrichus*.

Gnathotrupes Schedl

Gnathotrupes Schedl, 1951, Dusenia 2:125 (Type-species: *Gnathotrupes bolivianus* Schedl, monobasic)

Gnathotrypanus Wood, 1968, Great Basin Nat. 28:9 (Type-species: *Gnathotrypanus terebratus* Wood, original designation). New synonymy

In a review of this and related genera in North and Central America, including most of the species described from South America in *Gnathotrichus*, it was apparent that *Gnathotrichus* formed a compact group quite distinct from another somewhat diverse but definable genus from Central and South America. The name *Gnathotrupes* Schedl apparently is the oldest available name for this genus. To *Gnathotrupes* I assign all South American species described in *Gnathotrichus*, *Gnathotrichus bituberculatus* Blandford, from Guatemala, and *Gnathotrypanus terebratus* Wood and *electus* Wood, from Costa Rica. Through this action the genus *Gnathotrypanus* becomes a synonym of *Gnathotrupes*. The characters on which this division was based are discussed elsewhere.

Araptus hymenaeae (Eggers), n. comb.

Neodryocoetes hymenaeae Eggers, 1933, Mém. Trav. Lab. d'Ent. Mus. Nat. d'Hist. Nat., Paris 1(1):9 (Holotype, male; Gourdonville, Guayana Francaise; Paris Museum)

Neodryocoetes insularis Eggers, 1940, Arb. Morph. Tax. Ent. Berlin-Dahlem 7:128 (Holotype, female; Guadeloupe; Fleuteaux Coll.). New synonymy

Neodryocoetes caribaeus Blackman, 1942, Proc. U. S. Nat. Mus. 92:185 (Holotype, female; Trinidad; U.S. Nat. Mus.). New synonymy

Neodryocoetes guianae Blackman, 1942, Proc. U.S. Nat. Mus. 92:186 (Holotype, female; British Guiana; U.S. Nat. Mus.). New synonymy

Neodryocoetes hoodi Blackman, 1942, Proc. U.S. Nat. Mus. 92:187 (Holotype, female; Taboga Island, Panama; U.S. Nat. Mus.). New synonymy

Male cotypes of *hymenaeae* (Eggers) and *insularis* (Eggers) and the female holotypes of *caribaeus* (Blackman), *guianae* (Blackman), and *hoodi* (Blackman) were examined and compared directly to one another and to my material. Because of the limited material available to previous authors the extreme variability of the male frons of this species was not detected and several synonyms resulted. Each of several long series from Venezuela, Colombia, and Jamaica contain examples of the described variations clearly indicating that they all belong to one species.

Araptus laevigatus (Eggers), n. comb.

Pityophthorus laevigatus Eggers, 1933. Mém. Trav. Lab. d'Ent. Mus. Nat. d'Hist. Nat., Paris 1(1):6 (Holotype, female; St. Laurent du Maroni, Guayana Francaise; Paris Mus.).

Neopityophthorus insularis Eggers, 1940, Arb. Morph. Tax. Ent. Berlin-Dahlem 7:130 (Holotype, female; Trois Rivières, Guadeloupe; deposited in but not now in Eggers Coll.). New synonymy

Neodryocoetes guadeloupensis Schedl, 1951, Dusenia 2:73 (Replacement name). New synonymy

Cotypes of *laevigatus* Eggers and *insularis* Eggers were examined and compared to my material from Central and northern South America. All represent one species. It is common in fallen fruit on the forest floor. This species is very similar to but distinct from *costaricensis* (Schedl, 1938).

Araptus macer (Bright), n. comb.

Neodryocoetes macer Bright, 1972, Canadian Ent. 104:1666 (Holotype, female; 8 km or 5 miles S San Andres Tuxtla, Veracruz, Mexico; Canadian Nat. Coll.)

Neodryocoetes tuberculatus Bright, 1972, Canadian Ent. 104:1665 (Holotype, female, Lake Catemaco, Veracruz, Mexico; Canadian Nat. Coll.). New synonymy

Topotypic paratypes of *macer* (Bright) and of *tuberculatus* (Bright) were compared to one another and to my material from Central America. The limited material before Bright evidently did not include the variability found throughout the range of this species. His material fits very well within those limits. The name *macer* is selected for the valid name of this species under the first revisor principle.

Araptus politus (Blandford), n. comb.

Pityophthorus politus Blandford, 1904, Biol. Centr. Amer., Coleopt. 4(6):244 (Syntypes, male; Mexico; British Mus. Nat. Hist.)

Neodryocoetes hubbardi Blackman, 1942, Proc. U.S. Nat. Mus. 92:182 (Holotype, female; Kingston, Jamaica; U.S. Nat. Mus.). New synonymy

The two syntypes of *politus* (Blandford) and the female holotype of *hubbardi* (Blackman) were compared to my material. All repre-

sent the same common, rather widely distributed species. It occurs from Veracruz to Costa Rica, in Haiti, and in Jamaica.

Araptus tabogae (Blackman)

Neodryocoetes tabogae Blackman, 1942, Proc. U.S. Nat. Mus. 92:184 (Holotype, female; Taboga Island, Panama; U.S. Nat. Mus.).

Neodryocoetes vinealis Bright, 1972, Canadian Ent. 104:1667 (Holotype, female; Ejipantla, 8 km or 5 miles S San Andres Tuxtla, Veracruz, Mexico; Canadian Nat. Coll.). New synonymy

The holotypes of *tabogae* Blackman and *vinealis* Bright and 10 other specimens from Costa Rica were examined. While the Veracruz record is a significant extension of the range of this species, the specimen is entirely typical of the species. For this reason *vinealis* is placed in synonymy as indicated above.

Cnesinus elegantis Wood

Cnesinus elegantis Wood, 1967, Great Basin Nat. 27:79 (Holotype, female; Volcan Zunil, Quezaltenango, Guatemala; Wood Coll.)

Cnesinus zapotecus Bright, 1972, Canadian Ent. 104:1493 (Holotype, female; 5 km or 3 miles N Suchixtepec, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

A topotypic female paratype of *zapotecus* Bright has the epistomal tubercles slightly smaller and more closely spaced than is seen in the type series of *elegantis* Wood, but except for this feature it and a male paratype are identical to *elegantis*. However, Bright's Figure 2 of this species is entirely normal for this species and removes all doubt concerning the synonymy.

Coccotrypes advena Blandford

Coccotrypes advena Blandford, 1894, Trans. Ent. Soc. London 1894:100 (Holotype, female; Nagasaki, Japan; British Mus. Nat. Hist.)

Thamnurgides persicae Hopkins, 1915, U.S. Dept. Agric. Rept. 99:45 (Holotype, female; Honolulu, Hawaii; U.S. Nat. Mus.). New synonymy

This species has been introduced from the Indo-Malayan area into Japan, most Pacific Islands, northern South America, and several of the Antilles islands, including Cuba. Although numerous synonyms have been detected, the synonymy of *persicae* (Hopkins) with *advena* Blandford, the oldest available name for the species, has not been published. The holotypes of both species were examined and compared directly to my material. Schedl (1961, Rev. Ent. Mocambique 4[2]:728) treated *persicae* as a synonym of *sannio* (Schaufuss, 1897), however, the interstrial bristles of a syntype and of many other African specimens are shorter and more strongly flattened. In all probability part or all of the African population constitutes at least a different geographical race. Additional material must be studied to resolve this problem. Regardless of the outcome, the name *advena* has priority and will stand as the valid name of the species.

Corthylocurus barbatus (Blandford)

Brachyspartus barbatus Blandford, 1904, Biol. Centr. Amer., Coleopt. 4(6):265 (Holotype, female; Volcan de Chiriqui, Chiriqui, Panama; British Mus. Nat. Hist.).

Corthylocurus cincinnatus Bright, 1972, Canadian Ent. 104:1379 (Holotype, female; 21 km or 13 miles N Ocozocoautla, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

The female holotypes of *barbatus* (Blandford) and *cincinnatus* Bright, and 86 other specimens from Puebla to Costa Rica, were examined. The holotype of *cincinnatus* has the median frontal elevation slightly higher and the epistomal tufts of hair slightly larger than is seen in the average specimen, but all characters fall well within the range of variation of this species. For this reason *cincinnatus* is placed in synonymy as indicated above.

Corthylocurus mexicanus (Schedl)

Brachyspartus mexicanus Schedl, 1950, Dusenia 1:163 (Holotype, female; Comitan, Chiapas, Mexico; Schedl Coll.).

Corthylus anomalus Bright, 1972, Canadian Ent. 104:1378 (Holotype, female; 5.6 km or 3.5 miles S Suchixtepec, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

The holotype of *mexicanus* (Schedl) is a female, not a male as stated in the original description. This holotype and two topotypic paratypes of *anomalus* were compared directly to my material; all represent the same species.

Corthylus mexicanus Schedl

Corthylus mexicanus Schedl, 1950, Dusenia 1:159 (Holotype, male; Comitan, Chiapas, Mexico; Schedl Coll.)

Corthylus glabinus Bright, 1972, Canadian Ent. 104:1372 (Holotype, female; 14 km or 9 miles SW Teopisca, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

Two paratypes from 3.5 miles S Suchixtepec, Oaxaca, Mexico, and the holotype of *mexicanus* Schedl were compared directly to my material. One species is represented by these specimens. It is a rather common species from Puebla and Veracruz to Chiapas.

Crypturgus pusillus (Gyllenhal)

Bostrichus pusillus Gyllenhal, 1813, Insecta Suecica descripta, Coleopt. 1(3):371 (Syntypes?; Sweden; Univ. Uppsala?).

Crypturgus atomus LeConte, 1868, Trans. Amer. Ent. Soc. 2:151 (Holotype, sex?; New York; Mus. Comp. Zool.). New synonymy

In a review of the genus *Crypturgus* for North America most of the Palaearctic species were examined in order to determine phylogenetic relationships. In doing this it was noted that *atomus* LeConte could not be distinguished from the Eurasian *pusillus*. The odd pattern of distribution of this species also suggests that it was introduced into North America at an early date. This synonymy was independently noted by Bright and reported to me through correspondence at

about the same time I detected it. The holotype of *atomus* was compared directly to my North American specimens and these were compared to 26 European specimens of *pusillus*.

Dendrocranulus carbonarius (Ferrari)

Xylocleptes carbonarius Ferrari, 1867, Die Forst- und Baumsuchtschädichen Borkenkäfer, p. 41 (Syntypes; Cuba; not located)

Xylocleptes floridensis Hopkins, 1915, U.S. Dept. Agric. Rept. 99:43 (Holotype, female; Biscayne Bay, Florida; U.S. Nat. Mus.). New synonymy

Xylocleptes anonae Hopkins, 1915, U.S. Dept. Agric. Rept. 99:43 (Holotype, female; Florida; U.S. Nat. Mus.). New synonymy

The holotypes of *floridensis* (Hopkins) and *anonae* (Hopkins) were compared directly to one another and to my specimens from Cuba. All represent the same species. These very old Cuban specimens were labeled *carbonarius* by an unknown authority. They fit Ferrari's description, but confirmation of their identity is needed.

Dendrocranulus cucurbitae (LeConte)

Xylocleptes cucurbitae LeConte, 1879, Bull. U.S. Geol. Survey 5:519 (Holotype, female; Utah; Mus. Comp. Zool.).

Xylocleptes californicus Hopkins, 1915, U.S. Dept. Agric. Rept. 99:44 (Holotype, female; Pomona, California; U.S. Nat. Mus.). New synonymy

Xylocleptes venturina Hopkins, 1915, U.S. Dept. Agric. Rept. 99:44 (Holotype, female; Ventura Co., California; U.S. Nat. Mus.). New synonymy

Xylocleptes punctatus Hopkins, 1915, U.S. Dept. Agric. Rept. 99:44 (Holotype, female; Mesilla, New Mexico; U.S. Nat. Mus.). New synonymy

The holotypes of *cucurbitae* (LeConte), *californicus* (Hopkins), *venturina* (Hopkins), and *punctatus* (Hopkins) were examined and compared to my material from Utah, California, New Mexico, and Chihuahua. All clearly represent the same species. It is common in dying stems of *Cucurbita foetidissima* and probably will be found throughout the distribution of that plant.

Dendrocranulus macilentus (Blandford)

Dryocoetes macilentus Blandford, 1898, Biol. Centr. Amer., Coleopt. 4(6):190 (Lectotype, female; Jalapa, Veracruz, Mexico; British Mus. Nat. Hist., present designation)

Dendrocranulus grossopunctatus Schedl, 1937, Arch. Instit. Biol. Veg. Rio de Janeiro 3:155 (Holotype, female; San Isidro de Coronado, San José, Costa Rica; Schedl Coll.). New synonymy

Of the two syntypes in Blandford's series the first, a female, is here designated as the lectotype of *macilentus* (Blandford). This lectotype and the female holotype of *grossopunctatus* Schedl were compared directly to my female from Tapanti, Cartago, Costa Rica. All three represent the same unusually slender species.

Gnathotrichus consentaneus (Blandford)

Gnathotrichus consentaneus Blandford, 1904, Biol. Centr. Amer., Coleopt. 4(6): 247 (Lectotype, male, Totonicapan, Guatemala; British Mus. Nat. Hist., present designation).

Blandford included at least 18 specimens from several localities under the name *consentaneus* Blandford when it was described but stated that it was named from the Totonicapan specimens. In his series pins 1, 7, and 8 bear Totonicapan specimens of this species; the male on the first pin has been regarded as the type for many years and is here designated as the lectotype of *consentaneus*. Pins 3 and 5 and apparently another specimen of this series now in the Schedl collection bear specimens from Totonicapan of *sulcatus* (LeConte). The remainder of the series will be discussed elsewhere. The above action reestablishes the name *consentaneus* in the literature as a valid species.

Hylastes salebrosus (Eichhoff)

Hylastes salebrosus Eichhoff, 1868, Berliner Ent. Zeitschr. 12:146 (Lectotype, female; Carolina; U.S. Nat. Mus., present designation).

Hylastes scobinosus Eichhoff, 1868, Berliner Ent. Zeitschr. 12:146 (Lectotype, male?; Carolina; lost with Hamburg Mus.). New synonymy

Hylastes salebrosus Eichhoff and *scobinosus* Eichhoff were named from syntypic series which were destroyed with the Hamburg Museum except for two cotypes of *salebrosus* now in the U.S. National Museum of Natural History. The first of the two cotypes of *salebrosus* is a female of this species, the second is of *porculus* Erichson. I here designate the first cotype as the lectotype of *salebrosus* Eichhoff. A "cotype" of *scobinosus* in the U.S. National Museum was sent by Eichhoff to Schwarz; however, that specimen is from "Tennese" and cannot be a cotype. Because it is the only known specimen examined by Eichhoff it is used as the basis of this species. It is a specimen of *salebrosus*.

Hypothenemus seriatus (Eichhoff)

Stephanoderes seriatus Eichhoff, 1871, Berliner Ent. Zeitschr. 15:133 (Lectotype, female; New Orleans, Louisiana; Brussels Mus., present designation).

Stephanoderes pulverulentus Eichhoff, 1871, Berliner Ent. Zeitschr. 15:133 (Syntypes?; Mexico; presumably lost with Hamburg Mus.). New synonymy

The names *pulverulentus* (Eichhoff) and *seriatus* (Eichhoff) were validated on the same page. Since publishing synonymy involving *pulverulentus* (Wood, 1972, Great Basin Nat. 32:50) I have examined three female syntypes of *seriatus*. These syntypes are identical to the material reported in that paper as *pulverulentus*. Because the identity of *pulverulentus* was based on Eggers's homotypes, the original series having been destroyed, I select *seriatus* Eichhoff as the valid name for this species and designate the first syntype in the Chapius series as its lectotype.

Ips spinifer (Eichhoff)

Tomicus spinifer Eichhoff, 1878, Mém. Soc. Roy. Sci. Liége (2)8:499 (Holotype, sex?; California; lost with Hamburg Mus.).

Orthotomicus sabinianae Hopping, 1963, Canadian Ent. 95:64 (Holotype, male; Middletown, Lake Co., California; California Acad. Sci.). New synonymy

The name *spinifer* (Eichhoff was placed in synonymy by Swaine (1918, Dom. Canada Dept. Agric. Ent. Br. Tech. Bull. 14(2):114) under the name *latidens* (LeConte). As a result, Hopping presumed Swaine's action was correct, overlooked the description, and, consequently, named *sabinianae* in his review of the genus. Eichhoff described the pair of large frontal tubercles and the large, cylindrical, declivital spine 3 with sufficient clarity that there is no question whatever as to the identity of his species even though the type is lost.

Leperisinus aculeatus (Say)

Hylesinus aculeatus Say, 1824, Jour. Acad. Nat. Sci. Philadelphia 3:322 (Syntypes?; Missouri; evidently lost)

Hylesinus imperialis Eichhoff, 1868, Berliner Ent. Zeitschr. 12:149 (Syntypes; Wisconsin and Georgia; lost with Hamburg Mus.). New synonymy

A review of all North American *Leperisinus* indicates that the only species of this genus that could possibly occur in Wisconsin or Georgia, and fall within the size limitations of 1¼-1½ lin. (2.65-3.18 mm) set by Eichhoff for his *Hylesinus imperialis*, is *aculeatus* (Say). Since *aculeatus* is a common and variable species, with respect to the color pattern formed by the abundant scales, because all syntypes of *imperialis* evidently were lost with the Hamburg Museum, and in the absence of all information that might suggest any other alternative, I place *imperialis* in synonymy under *aculeatus*.

Micracis lignator Blackman

Micracis lignator Blackman, 1928, New York St. Coll. For., Syracuse, Tech. Pub. 25:195 (Holotype, female; Tucson, Arizona; U.S. Nat. Mus.)

Micracis truncatus Wood, 1956, Canadian Ent. 88:152 (Holotype, female; 17 km NE Jacala, Hidalgo, Mexico; Snow Ent. Mus., Univ. Kansas). New synonymy

Since 1956, several series have been collected in Arizona and Mexico that largely fill the gap in characters between *lignator* Blackman and *truncatus* Wood. Although minute differences are still apparent that might justify the recognition of subspecies, I here place *truncatus* in synonymy under *lignator*.

Micracis swainei Blackman

Micracis swainei Blackman, 1920, Mississippi Agric. Expt. Sta. Tech. Bull. 9:32 (Lectotype, female; Iuka, Mississippi; U.S. Nat. Mus.)

Micracis photophilus Wood, 1956, Canadian Ent. 88:149 (Holotype, female; El Salto, San Luis Potosi, Mexico; Snow Ent. Mus., Univ. Kansas). New synonymy

After examining more than 463 specimens taken from New York to Honduras, including the type series of *swainei* Blackman and *photophilus* Wood, I must recognize only one species among this material. Specimens from the eastern United States are distinguishable from those from most of Mexico; however, the characters change over a gradual, clinal gradient making the recognition of geographical races difficult or impossible. It occurs most commonly in *Salix* spp., although other hosts are acceptable.

Micracis suturalis LeConte

Micracis suturalis LeConte, 1868, Trans. Amer. Ent. Soc. 2:165 (Lectotype, female; Illinois; Mus. Comp. Zool., present designation)

Micracis meridianus Blackman, 1920, Mississippi Agric. Expt. Sta. Tech. Bull. 9:29 (Lectotype, female; Agricultural College, Mississippi; U.S. Nat. Mus., present designation). New synonymy

The female syntype from Illinois, presently bearing type label No. 1014 in the LeConte series, is here designated as the lectotype of *suturalis* LeConte. The female in the syntypic series of *meridianus* Blackman that was labeled "Type" by Blackman, but never so designated, is here designated as the lectotype of *meridianus* Blackman. These lectotypes and all other syntypic specimens in the Museum of Comparative Zoology and in the U.S. National Museum, were examined and compared to my material. I am unable to see differences in this material and place *meridianus* in synonymy under LeConte's name.

Monarthrum querneus Wood

Monarthrum querneus Wood, 1967, Great Basin Nat. 27:50 (Holotype, male; 5 km or 3 miles E Morelia, Michoacan, Mexico; Wood Coll.).

Monarthrum bifidus Bright, 1972, Canadian Ent. 104:1382 (Holotype, male; 13 km or 8 miles E San Cristobal de las Casas, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

Two topotypic paratypes of *bifidus* Bright were compared directly to the type series of *querneus* Wood. Only one species is represented by these specimens. This species occurs in *Quercus* logs from Michoacan to Honduras.

Orthotomicus caelatus (Eichhoff)

Tomicus caelatus Eichhoff, 1868, Berliner Ent. Zeitschr. 11:402 (Syntypes; Pennsylvania, Carolina; lost with Hamburg Mus. except two supposed syntypes in the U.S. Nat. Mus.).

Xyleborus vicinus LeConte, 1874, Trans. Amer. Ent. Soc. 5:72 (Holotype, female; British Columbia; Mus. Comp. Zool.). New synonymy

Xyleborus punctipennis LeConte, 1878, Proc. Amer. Philos. Soc. 17:624 (Holotype, female; Marquette, Michigan; Mus. Comp. Zool.). New synonymy

The names *vicinus* (LeConte) and *punctipennis* (LeConte) have been retained in the literature as distinct species largely because their types were not seen by specialists. The holotypes of both *vicinus* and *punctipennis* were examined and were found to represent normal specimens of *caelatus* (LeConte). Although the type series of *caelatus* was mostly destroyed with the Hamburg Museum, Eichhoff sent two presumed syntypes to the U.S. National Museum that serve to fix the identity of his species.

Coccotrypes indicus (Eggers), n. comb.

Thamnurgides indicus Eggers, 1936, Ann. Mag. Nat. Hist. (10) 17:631 (Holotype, female; Sakalaspur, Mysore, India; British Mus. Nat. Hist.)

Xyleborus conspeciens Schedl, 1936, Archiv. Inst. Biol. Veg. Rio de Janeiro 3:110

(Holotype, female; locality not given, presumably Brazil; Schedl Coll.). New synonymy

Coccotrypes insularis Eggers, 1940 (nec Eggers 1940:127), Arb. Morph. Tax. Ent. Berlin-Dahlem 7:129 (Lectotype, female; Trois-Rivières, Guadeloupe; U.S. Nat. Mus., designated by Anderson and Anderson, 1971, Smithsonian Contrib. Zool. 94:15). New synonymy

Poecilips eggersi Schedl, 1952, Dusenia 3:347 (Replacement name). New synonymy

The holotypes of *indicus* (Eggers) and *conspeciens* (Schedl), and the lectotype of *insularis* Eggers were all examined and compared to my material. Only one species is represented. This species has been introduced from the Indo-Malayan area into northern South America, Central America, the Antilles islands, and one series was intercepted in Florida, although it probably is not yet established there.

Phloeoborus asper Erichson

Phloeoborus asper Erichson, 1836, Archiv Naturgesch. 2(1):55 (Holotype, male; Brazil; Zool. Mus. Berlin)

Phloeoborus ovatus Chapuis, 1869, Synopsis des Scolytides, p. 15 (Lectotype, male; Cayenne; Brussels Mus., present designation). New synonymy

Phloeoborus rugatus Blandford, 1897, Biol. Centr. Amer. Coleopt. 4(6):153 (Lectotype, female; Chontales, Nicaragua; British Mus. Nat. Hist., present designation). New synonymy

The male holotype of *asper* Erichson, the three male syntypes of *ovatus* Chapuis, and the two female syntypes of *rugatus* Blandford were all compared to my long series of this species from Venezuela. It is obvious that all three names apply to the same, easily recognized species. The first syntype of *ovatus* and the first syntype of *rugatus* are here designated as lectotype of their respective species as indicated above.

Phloeoborus rudis Erichson

Phloeoborus rudis Erichson, 1836, Archiv Naturgesch. 2(1):55 (Lectotype, female; Brazil; Zool. Mus. Berlin, present designation)

Phloeoborus elongatus Chapuis, 1869, Synopsis des Scolytides, p. 13 (Holotype, male; Brazil; Brussels Mus.). New synonymy

Phloeoborus rugipennis Eggers, 1942, Arb. Morph. Taxon. Ent. Berlin-Dahlem 9:271 (Holotype, female; San Salvador; U.S. Nat. Mus.). New synonymy

Of the specimens of *rudis* Erichson now in the Zoologische Museum in Berlin, it appears that only the first two, both females, were in the original series. Since the first of these two syntypes has been regarded as the type, it is here designated as the lectotype of *rudis* as indicated above. This lectotype was compared directly to the male holotype of *elongatus* and to my specimens from Panama and Peru; my specimens were later compared to the female holotype of *rugipennis*. All apparently represent the same slightly variable species.

Phloeotribus armatus Blandford

Phloeotribus armatus Blandford, 1897. Biol. Centr. Amer., Coleopt. 4(6):166 (Holotype, male; Volcan de Chiriqui, Panama; British Mus. Nat. Hist.)

Phloeotribus mixtecus Bright, 1972, Canadian Ent. 104:1494 (Holotype, female; 26 miles S Juchatengo, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

Two topotypic paratypes of *mixtecus* Bright were compared to my series that previously had been compared to the male holotype of *armatus* Blandford. This species occurs from southern Mexico to Panama.

Phloeotribus demessus Blandford

Phloeotribus demessus Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):165 (Lectotype, female; Toxpam, a probable misspelling of Tuxpan, Veracruz, Mexico; British Mus. Nat. Hist.).

Phloeotribus tuberculatus Eggers, 1951, Ent. Blätt. 46:147 (Holotype, female; Turrialba, Cartago, Costa Rica; U.S. Nat. Mus.). New synonymy

The second specimen, a female, in the Blandford series of *demessus* has been labeled type and has been regarded as the type of this species, although it has never been so designated. I here designate that female syntype as the lectotype of *demessus*. This specimen was compared to my series and some of these were later compared to the female holotype of *tuberculatus* Eggers; all clearly represent the same species.

Phloeotribus pilula Erichson

Hylesinus pilula Erichson, 1847, Archiv Naturgesch. 13(1):138 (Lectotype, male; Peru; Zool. Mus. Berlin, present designation)

Phloeotribus obliquus Chapuis, 1869, Synopsis des Scolytides, p. 45 (Syntypes; Mexique, Nouvelle-Grenada; Brussels Mus.). New synonymy

Phloeotribus manni Blackman, 1943, Proc. U.S. Nat. Mus. 94:385 (Holotype, female; Rio Madeira, Brazil; U.S. Nat. Mus.). New synonymy

Of three specimens presumed to be syntypes of *pilula* (Erichson) now in the Zoological Museum in Berlin, only the first specimen, a male, is of the species usually designated by this name. The second and third specimens are females of a different species not presently known to me and probably were not part of the original series. In order to avoid possible confusion at a later date, I here designate the first specimen in the series as the lectotype of *pilula*. This same species was named *obliquus* by Chapuis. Under the name *obliquus* in the Brussels Museum were four specimens in 1969; the first syntype is of *transversus* Chapuis (apparently remounted on the wrong pin when the glue deteriorated) and did not fit the description; the second syntype did fit the description and it was identical with the third and fourth specimens labeled "ex-typis." In 1971, when I reexamined these specimens, the second syntype was missing from the pin. That specimen previously had been compared to my series from Peru and to the two Chapuis ex-typis specimens and are of the same species as the lectotype of *pilula*. The holotype of *manni* Blackman was also compared directly to my specimens from Peru and is also this species.

This species is abundant in *Brosmium* sp. from Chiapas, Mexico, to Peru and Brazil.

Phloeotribus setulosus Eichhoff

Phloeotribus setulosus Eichhoff, 1868, Berliner Ent. Zeitschr. 12:149 (Lectotype, male; Colombia; Brussels Mus., present designation).

Phloeotribus asperatus Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6):166 (Holotype, male; Panachel, Guatemala; British Mus. Nat. Hist.). New synonymy

Two syntypes, a male and a female, of *setulosus* Eichhoff are in the Brussels Museum. The male, labeled "Colombie," not Carolina, as reported by Eichhoff, is here designated as the lectotype of this species. It is identical to the male holotype of *asperatus* Blandford. Both types were compared directly to my material from Central and South America and they obviously represent the same species.

This is the most abundant and widely distributed Central and South American species of *Phloeotribus;* it occurs in a wide variety of host trees. It is easily misidentified, and numerous specimens in museums under this name are not of this species.

Pityoborus frontalis Wood

Pityoborus frontalis Wood, 1971, Brigham Young Univ. Sci. Bull. Biol. Ser. 15(3):49 (Holotype, female; 13 km S El Cameron, Oaxaca, Mexico; Wood Coll.).

Pityoborus severus Bright, 1972, Canadian Ent. 104:1676 (Holotype, female; 5 km or 3 miles N Suchixtepec, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

Two paratypes of *severus* Bright from 8 miles S Miahuatlan, Oaxaca, Mexico, were compared to the holotype and allotype of *frontalis* Wood. They are identical in every respect.

Pityoborus secundus Blackman

Pityoborus secundus Blackman, 1928, Bull. New York St. Coll. For., Syracuse, Tech. Pub. 25:146 (Holotype, female; La Sal Mts., Utah; U.S. Nat. Mus.)

Pityoborus tertius Blackman, 1942, Proc. U.S. Nat. Mus. 92:202 (Holotype, female; Chalco, Districto Federal, Mexico; U.S. Nat. Mus.). New synonymy

Pityoborus intonsus Wood, 1958, Great Basin Nat. 28:54 (Holotype, female; 23 km or 14 miles W Texmelucan, Puebla, Mexico; Snow Ent. Mus., Univ. Kansas). New synonymy

Pityoborus immitus Bright, 1972, Canadian Ent. 104:1674 (Holotype, female; 68 km W Durango, Durango, Mexico; Canadian Nat. Coll.). New synonymy

Pityoborus ramosus Bright, 1972, Canadian Ent. 104:1677 (Holotype, female; 5.6 km or 3.5 miles S Suchixtepec, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

This species has been collected at 14 rather widely separated localities from Utah to Oaxaca. The average specimen in each series is slightly different from those in almost every other series. Several independent clinal variations between series are also apparent. However, the differences are so minute and inconsistent within most series that the only logical solution appears to be the grouping of all of this material into one species at least until considerably more material is available for study from many more localities. This

decision was based on 169 specimens including the holotypes and type series of *secondus* Blackman, *tertius* Blackman and *intonsus* Wood, and on female paratypes of *immitus* Bright and *ramosus* Bright. The last four names listed, therefore, are placed in synonymy under *secundus*.

Pycnarthrum hispidum (Ferrari)

Hypoborus (?) *hispidus* Ferrari, 1867, Die Forst.- und Baunzuchtschädlichen Borkenkäfer, p. 19 (Syntypes?, Cuba; presumably in Vienna Mus.)

Nemobius lambottei Chapuis, 1869, Synopsis des Scolytides, p. 42 (Lectotype, female; Teapa, presumably Tabasco, Mexico; Brussels Mus., present designation). New synonymy

Pycnarthrum gracile Eichhoff, 1878, Mém. Soc. Roy. Sci. Liége (2)8:104 (Syntypes?; Cuba; some syntypes lost with Hamburg Mus., one apparent syntype in U.S. Nat. Mus.). New synonymy

Pycnarthrum quadraticolle Eichhoff, 1878,, Mém. Soc. Roy. Sci. Liége (2)8:106 (Lectotype, male; Mexico; U.S. Nat. Mus., present designation). New synonymy

Pycnarthrum transversum Blandford, 1897, Biol. Centr. Amer., Coleopt. 4(6): 177 Lectotype, female; Mirandilla, Guatemala; British Mus. Nat. Hist., present designation). New synonymy

Pycnarthrum reimoseri Schedl, 1934, Ent. Blätt. 30:208 (Syntypes, females; Jimenez on Osa Penninsula, and Volcan Irazu, Costa Rica; Vienna Mus. and Schedl. Coll.). New synonymy

Pycnarthrum reticulatus Schedl, 1940, An. Esc. Nac. Cienc. Biol., Mexico, 1:335 (Syntypes; Tonala and Mapastec in Chiapas, Tuxtepec in Oaxaca, and Cardel in Veracruz, Mexico; Schedl and Dampf Collections). New synonymy

This is the only widely distributed, common *Pycnarthrum* species in Mexico, Central America, and southern Florida to Guadeloupe. It breeds in *Ficus* spp. and it is readily attracted to light. It is the only species in this genus known to occur north of Honduras and Guadeloupe Island.

Authentic specimens of *hispidus* (Ferrari) have not been examined although several specimens supposedly compared to the types by Eggers were examined; since no other species of this genus occurs in Cuba, the association appears certain. The three syntypes of *lambottei* (Chapuis) were examined and the first of these, a female from Teapa, is here designated as the lectotype of *Nemobius lambottei* Chapuis. A specimen in the U.S. National Museum, sent by Eichhoff, bears the labels "*Pycnarthrum gracile* Eich., Type, Cuba, 50," and is presumed to be a syntype. That specimen is here designated as the lectotype of *Pycnarthrum gracile* Eichhoff, since the remainder of the Eichhoff series was destroyed with the Hamburg Museum. From syntypes of *quadraticolle* Eichhoff in the U.S. National Museum a male was selected, labeled, and is here designated as the lectotype of this species. Blandford based *transversum* on four female syntypes; the left specimen (with the elytra completely closed) on the first pin in this series is here designated as the lectotype of *transversum* Blandford. One female cotype at the U.S. National Museum and several other specimens identified by Schedl as *reimoseri* Schedl were examined; several specimens identified by Schedl as *reticulatus* Schedl were also studied. All of the above

material and several hundred other specimens from throughout its distribution were examined and found to represent one species.

Pseudopityophthorus declivis Wood

Pseudopityophthorus declivis Wood, 1971, Brigham Young Univ., Sci. Bull. Biol. Ser. 15(3):50 (Holotype, female; Laguna Santa Maria, Nayarit, Mexico; Wood Coll.)

Pseudopityophthorus truncatus Bright, 1972, Canadian Ent. 104:1673 (Holotype, male; 184 km S Oaxaca, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

Pseudopityophthorus curtus Bright, 1972, Canadian Ent. 104:1674 (Holotype, female?; km or 8 miles N Ocosingo, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

The holotypes of *declivis* Wood and *curtus* Bright and two topotypic paratypes of *truncatus* Bright were compared directly to one another. The specimen of *declivis* is intermediate in size between the slightly smaller *curtus* and the slightly larger *truncatus*. The declivital punctures in *truncatus* are distinctly smaller, particularly toward the apex and the interstrial bristles are very slightly longer and finer. The posterior areas of the pronotum of *curtus* are more brightly shining, but the prothoraxic joint has been broken and the anterior unit remounted with the posterior areas; the possibility exists that the anterior unit came from another slightly larger specimen. In view of the paucity of material from widely separated areas I presently consider *truncatus* and *curtus* to be synonyms of *declivis*. It is possible that *curtus* might eventually be restored to subspecific rank when sufficient material is available from more localities.

Pseudopityophthorus hondurensis Wood

Pseudopityophthorus hondurensis Wood, 1967, Great Basin Nat. 27:42 (Holotype, male; Buenos Aires, Cortes, Honduras; Wood Coll.)

Pseudopityophthorus montanus Bright, 1972, Canadian Ent. 104:1667 (Holotype, male; Mt. Tzontehuitz, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

Two topotypic paratypes of *montanus* Bright were compared to the type series of *hondurensis* Wood. Only one species is represented by this material.

Pseudopityophthorus micans Wood

Pseudopityophthorus micans Wood, 1967, Great Basin Nat. 27:44 (Holotype, male, 96 km or 60 miles W Durango, Durango, Mexico; Wood Coll.)

Pseudopityophthorus squamosus Bright, 1972, Canadian Ent. 104:1670 (Holotype, female; 14 km or 9 miles W La Ciudad, Durango, Mexico; Canadian Nat. Coll.). New synonymy

A topotypic female paratype of *squamosus* Bright was compared to the type series of *micans* Wood. Although most paratypes of *micans* have the elytra entirely glabrous, some have declivital scales exactly as seen in *squamosus*. Bright's name *squamosus* must be placed in synonymy under *micans*.

Pseudopityophthorus opacicollis Blackman

Pseudopityophthorus opaciocollis Blackman, 1931, J. Washington Acad. Sci. 21: 235 (Holotype, male; Santa Catalina Mts., Arizona; U.S. Nat. Mus.).

Pseudopityophthorus aesculinus Bright, 1972, Canadian Ent. 104:1672 (Holotype, female; 112 km or 70 miles N Oaxaca, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

Two topotypic paratypes of *aesculinus* Bright were compared to two paratypes and 38 other specimens of *opacicollis* Blackman taken from Arizona to Tlaxcala, Mexico. This species is somewhat more variable than was indicated in Blackman's description, but the paratypes of *aesculinus* are average specimens and Bright's species must be placed in synonymy under *opacicollis*.

Pseudopityophthorus pruinosus (Eichhoff)

Pityophthorus pruinosus Eichhoff, 1878, Mém. Soc. Roy. Sci. Liége (2)8:187 (Syntypes; Carolina; most were lost with the Hamburg Mus., one is in the U.S. Nat. Mus.)

Pseudopityophthorus pulvereus Blackman, 1931, J. Washington Acad. Sci. 21:232 (Holotype, male; Chiricahua Reserve, Arizona; U.S. Nat. Mus.). New synonymy

Pseudopityophthorus tropicalis Wood, 1967, Great Basin Nat. 27:43 (Holotype, male; Zamorano, Morazan, Honduras; Wood Coll.). New synonymy

Pseudopityophthorus convexus Bright, 1972, Canadian Ent. 104:1672 (Holotype, male; 184 km or 115 miles S Oaxaca, Oaxaca, Mexico; Canadian Nat. Coll.). New synonymy

The only known syntype of *pruinosus* (Eichhoff), the type series of *pulvereus* Blackman and of *tropicalis* Wood, one topotypic paratype of *convexus* Bright, and 83 other specimens of this species from Arizona and Mexico were examined in a review of all species of this genus. In attempting to make a key to identify the described species it was noted that some of the minute characters on which these species were based were not consistent within or between series. It became necessary to reevaluate my concept of this species and broaden it to include *pulvereus*, *tropicalis*, and *convexus* as synonyms of *pruinosus*.

Pseudopityophthorus singularis Wood

Pseudopityophthorus singularis Wood, 1971, Brigham Young Univ. Sci. Bull. Biol. Ser. 15(3):50 (Holotype, male; 1 km W Las Vigas, Veracruz, Mexico; Wood Coll.)

Pseudopityophthorus acuminatus Bright, 1972, Canadian Ent. 104:1671 (Holotype, male; 13 km or 8 miles NE San Cristobal de las Casas, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

Two topotypic paratypes of *acuminatus* Bright were compared to the type series of *singularis*. Only one species is represented by this material.

Pseudopityophthorus tenuis Wood

Pseudopityophthorus tenuis Wood, 1959, Great Basin Nat. 19:1 (Holotype, male; 18 km or 11 miles NE Jacala, Hidalgo, Mexico; Snow Ent. Mus., Univ. Kansas)

Pseudopityophthorus hirsutus Bright, 1972, Canadian Ent. 104:1668 (Holotype, male; 8 km or 5 miles SE Teopisca, Chiapas, Mexico; Canadian Nat. Coll.). New synonymy

A topotypic paratype of *hirsutus* Bright was compared to the type series and to 22 other representatives of this species from Veracruz. The sculpture of the frons is slightly variable throughout the range of the species, but the specimen of *hirsutus* fits well within the limits of that variation.

Stenocleptus sulcatus (Bruck)

Pseudothysanoes sulcatus Bruck, 1936, Bull. S. California Acad. Sci. 35:33 (Holotype, male; Mt. Wilson, Los Angeles Co., California; Ohio State Univ. Coll.).

Stenocleptus ceanothi Blackman, 1943, Proc. U.S. Nat. Mus. 93:358 (Holotype, female; Yosemite Nat. Pk., California; U.S. Nat. Mus.). New synonymy

Stenocleptus rhois Blackman, 1943, Proc. U.S. Nat. Mus. 93:357 (Holotype, female; Orange Co., California; U.S. Nat. Mus.). New synonymy

This rare species is known from five short series in which most of the specimens are in poor condition caused by the adherence of plant resins and frass to the beetles. Minute differences may be seen between every series, although their basic features are identical. Until considerably more material is available I place *ceanothi* Blackman and *rhois* Blackman in synonymy under *sulcatus* (Bruck). The entire type series of both of Blackman's species, two paratypes of *sulcatus*, and four other specimens were used as the basis for this synonymy.

Thysanoes texanus Blackman

Thysanoes texanus Blackman, 1943, Proc. U.S. Nat. Mus. 93:353 (Holotype, female; Brownsville, Texas; U.S. Nat. Mus.).

Thysanoes vachelliae Blackman, 1943, Proc. U.S. Nat. Mus. 93:353 (Holotype, female; Brownsville, Texas; U.S. Nat. Mus.). New synonymy

Thysanoes ratamae Blackman, 1943, Proc. U.S. Nat. Mus. 93:354 (Holotype, female; Mexico; U.S. Nat. Mus.). New synonymy

Following a review of all described species of *Thysanoes*, including 160 specimens of this species and a direct comparison of their holotypes, it was concluded that *texanus* Blackman, *vachelliae* Blackman, and *ratamae* Blackman all represent one common species that occurs from southern Texas to Veracruz and Colima. The unique type of *ratamae* is in very poor condition, but frontal characters insure the correctness of my identification.

Trypopholeus striatulus (Mannerheim)

Cryphalus striatulus Mannerheim, 1853, Bull. Soc. Imp. Nat. Moscou 26:235 (Holotype, sex?: Lake Skeljamma, Kenai Penninsula, Alaska; presumably lost)

Trypophloeus nitidus Swaine, 1912, Canadian Ent. 44:349 (Lectotype, sex?; Weymouth, Nova Scotia; Canadian Nat. Coll., designated by Bright, 1967, Canadian Ent. 99:679). New synonymy

The Mannerheim collection contains no specimens under the name *striatulus* (Mannerheim) nor are there American specimens of this or a related genus among his undetermined American material. Mannerheim compared this species to the familiar European *Trypophoeus granulatus* (Ratzeburg). Considering Mannerheim's knowledge of the European fauna and the fact that the only species of American Cryphalini occurring north of British Columbia is *nitidus* Swaine, a species very similar to *granulatus*, I place *nitidus* in synonymy under *striatulus*. My specimen from Cantwell, Alaska, about 200 miles north of the type locality, is entirely typical of the species and confirms the existence of this species that far north.

Xyleborus capucinus Eichhoff

Xyleborus capucinus Eichhoff, 1869, Berliner Ent. Zeitschr. 12:281 (Holotype, female; Guadeloupe Island; Brussels Mus.)

Xyleborus rufithorax Eichhoff, 1869, Berliner Ent. Zeitschr. 12:281 (Holotype female; Brazil; Brussels Mus.). New synonymy

The female holotypes of *capucinus* Eichhoff and *ruftithorax* Eichhoff were examined and compared directly to my specimens. The holotype of *capucinus* is callow, partly crushed, and in poor condition, and the prothorax of *rufithorax* is not fully colored, but there is no question whatever as to their synonymy. The species is now known from Nayarit and Veracruz, Mexico, to Colombia and Brazil.

Xyleborus pubescens Zimmermann

Xyleborus pini Say (??): Eichhoff, 1868, Berliner Ent. Zeitschr. 11:401 (Erroneus identification)

Xyleborus pubescens Zimmermann, 1868, Trans. Amer. Ent. Soc. 2:145 (Lectotype, female; Southern States; Mus. Comp. Zool., present designation).

Xyleborus propinguus Eichhoff, 1869, Berliner Ent. Zeitschr. 12:281 (Lectotype, female; Amerique boreali; Brussels Mus., present designation). New synonymy

Various authors have treated as valid a species designated as *Xyleborus pini* Eichhoff. However, when the literature is searched the only Eichhoff reference to such a name is the erroneous identification and description of Say's species and the citation of the same species in synonymy. Neither reference validated this name; consequently, the oldest available name for this taxon is *pubescens* Zimmermann. The first of two female syntypes now in the LeConte collection is here designated as the lectotype of *pubescens* Zimmermann. The female syntype in the Brussels Museum is here designated as the lectotype of *propinguus* Eichhoff; it was compared directly to my homotypes of *pubescens* and is identical in all respects.

Xylosandrus curtulus Eichhoff

Xyleborus curtulus Eichhoff, 1869, Berliner Ent. Zeitschr. 12:281 (Holotype, female; Brazil; Institut Royal des Sciences Naturelles de Belgique, Brussels)

Xyleborus biseriatus Schedl, 1963, Reichenbachia 1:226 (Holotype, female; Nova Teutonia, Santa Catarina, Brazil; Schedl Coll.). New synonymy

The holotype of *Xyleborus curtulus* Eichhoff was compared directly to specimens which previously had been compared directly to the holotype of *biseriatus* Schedl. Only one species is represented.

Because a series from Caicedonia, Valle de Cauca, Colombia, indicated intergradation between this species and *zimmermanni* (Hopkins), they were treated as synonyms (Wood, 1966, Great Basin Nat. 26:33). Since then, many additional series of both species have been taken in a broad zone of sympatry without additional indications of intergradation. Both species are now considered valid, with *curtulus* occurring from Nayarit and Veracruz, Mexico, to Brazil, and *zimmermanni* from Florida and Guatemala to Venezuela.

UNDESCRIBED SPECIES OF NEARCTIC TIPULIDAE (DIPTERA), XI

Charles P. Alexander[1]

ABSTRACT.— New species and subspecies of Tipulidae from California and Alaska are described, including *Tipula* (*Trichotipula*) *frommeri*, *Tipula* (*Trichotipula*) *sanctaecruzae*, and *Tipula* (*Lunatipula*) *hastingsae diperona*, from California, and *Tipula* (*Pterelachisus*) *macleani* and *Limnophila byersi* from Alaska.

The preceding paper in this series was published in the *Great Basin Naturalist* 29:1-10.

The species discussed at this time are derived from three sources: two from California, the third from Alaska. The first Californian series is from the California Channel Islands in the Channel Islands National Monument west of Los Angeles including Santa Cruz, San Miguel, and San Nicolas islands, the materials having been collected chiefly by Dr. Charles L. Remington, his son, Eric E. Remington, and L. Serge Matlovsky. The named materials are preserved in the Peabody Museum, Yale University, New Haven, Connecticut. The second Californian collection is from various canyons in and near Death Valley, Panamint Mountains, in Riverside and San Bernardino counties, chiefly in conjunction with the P. L. Boyd Deep Canyon Desert Research Center. The survey is under the direction of Dr. Saul I. Frommer, presently assisted by Messrs. Irwin and LePré. The materials are to be preserved in the University of California, Riverside, Research Collection. The Alaskan materials are from Dr. George W. Byers of the University of Kansas, Lawrence; the specimens having been taken by Stephen M. MacLean, made in conjunction with the United States Biome Tundra Program at Prudhoe Bay, Alaska. I express my sincere thanks to all of the above for the privilege of examining these particularly interesting species.

Tipula (*Trichotipula*) *frommeri*, n. sp.

General coloration of thorax yellow, praescutal stripes bordered by pale brown, in cases the median area paler; legs yellow, tips of femora narrowly brown; wings weakly darkened, cell *Sc* and the stigma light brown, no trichia in outer wing cells; abdominal tergites conspicuously bicolored, bases broadly yellow, posterior borders brown, sternites and hypopygium more uniformly yellowed; male hypopygium with the beak of the inner dististyle long, with conspicuous setae.

MALE.— Length about 12 mm; wing 10 mm; antenna about 5.5 mm.

FEMALE.— Length about 13 mm; wing 11 mm; antenna about 2.5 mm.

[1]Amherst, Massachusetts.

Described from alcoholic materials. Frontal prolongation of head slightly shorter than the remainder, yellow; nasus long and slender; palpi with proximal two segments brown, third slightly paler, terminal segment elongate, light yellow. Antennae of male elongate; scape and pedicel yellow, flagellum dark brown, flagellar segments with conspicuous basal enlargements, verticils shorter than the segments. Head brownish yellow.

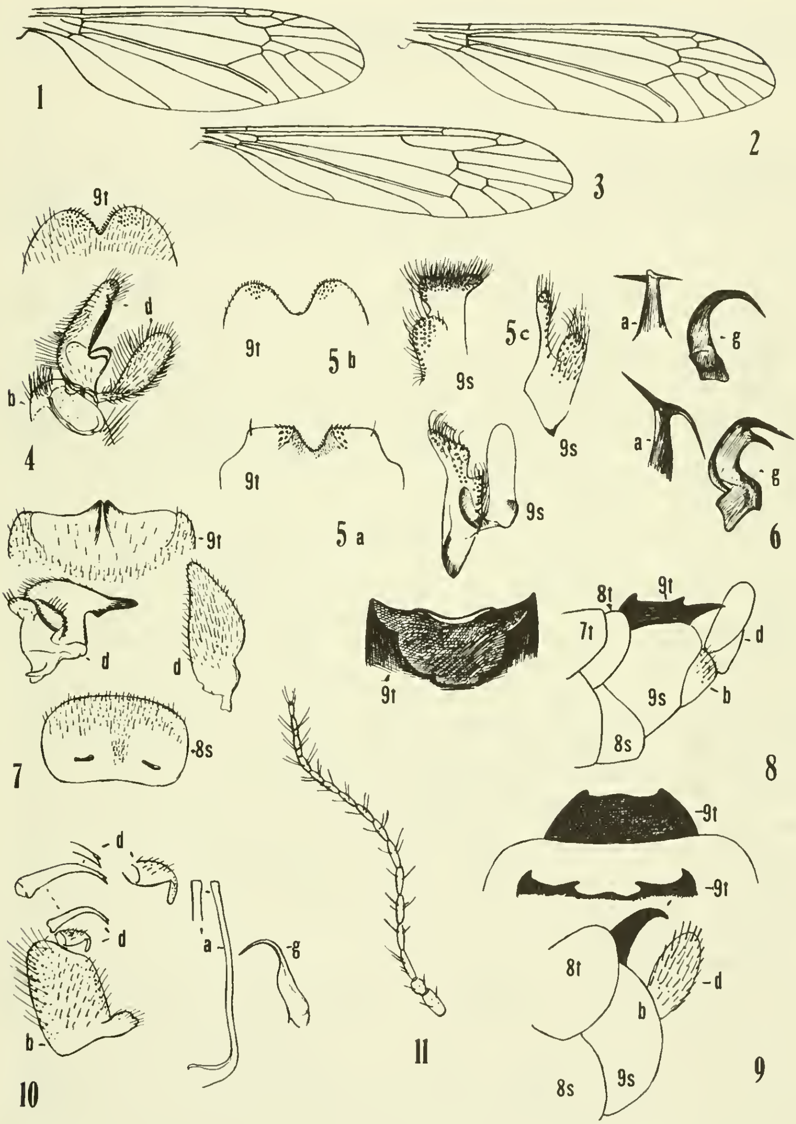
Pronotum yellow, center of scutum restrictedly darker. Mesonotal praescutum with four yellow stripes bordered by pale brown, in cases median area paler to produce a vague central stripe, as in *dorsolineata* and some others; scutal lobes yellow, ringed with pale brown; scutellum and postnotum brownish yellow, with erect setae. Pleura and pleurotergite yellowed, restrictedly darkened on cervical region, propleura, and pleurotergite. Halteres with stem yellow, knob infuscated. Legs with coxae and trochanters light yellow; femora yellow, appearing darker from abundant short darkened vestiture, tips narrowly brown; tibiae obscure yellow, tarsi passing into dark brown; claws small, simple. Wings (Fig. 1) weakly darkened, cell *Sc* and the stigma light brown; veins darker brown. Stigma with two or three microscopic trichia, outer cells without trichia. Venation: Petiole of cell M_1 from about one-half to two-thirds *m; m-cu* on M_4.

Abdominal tergites conspicuously bicolored, bases broadly yellow, posterior borders brown, on the proximal segments including also the narrow bases of the segments; sternites and hypopygium more uniformly yellow. Abdomen with conspicuous black setae. Male hypopygium (Fig. 4) with vestiture of tergal lobes, *t*, restricted in numbers, setae of emargination longer than a group of about 15 small blackened points near apex of each lobe. Basistyle, *b*, with a group of strong setae on outer margin of apex with more sparse longer bristles on inner side. Dististyles, *d*, as shown; outer style with very long black setae, longest exceeding transverse diameter of style; inner style with beak long, setae of base long and conspicuous, outer ones progressively shorter, apex of beak with numerous, very long, more delicate, yellow setae.

Habitat.— California.

Holotype, ♂, alcoholic, P. L. Boyd Desert Research Center, Riverside County, Thunderbolt, Horsethief Creek, gaging station in first permanent pool, Malaise, 15 May 1970 (Saul I. Frommer). Allotopotype, ♀, Deep Canyon, 4 mi. south of Palm Desert, 5680 ft., 24 May 1969 (M. E. Irwin and Saul I. Frommer); 24-471. Paratopotype, ♂, in Alexander Collection, 3.5 mi. south of Palm Desert, at Marker 58, 15 May 1969 (Frommer and LaPré); 24-472.

This interesting fly is named for Dr. Saul I. Frommer, capable student of the Diptera, in charge of the Deep Canyon Research Project. By means of the author's key to the Californian species of the genus *Tipula* (Crane flies of California, pp. 56-57; 1967), the present fly runs to couplets 11 and 12, including three species in the subgenus *Trichotipula* that lack trichia in the outer wing cells, these



Figs. 1-3. Wing venation: 1, *Tipula* (*Trichotipula*) *frommeri*, n. sp.; 2, *Tipula* (*Pterelachisus*) *macleani*, n. sp.; 3, *Limnophila byersi*, n. sp. Figs. 4-10. Male hypopygia: 4, *Tipula* (*Trichotipula*) *frommeri*, n. sp.; 5a, *Tipula* (*Trichotipula*) *sanctaecruzae*, n. sp.; 5b, *Tipula* (*Trichotipula*) *capistrano* Alexander; 5c, *Tipula* (*Trichotipula*) *beatula* Osten Sacken; 6, above *Tipula* (*Lunatipula*) *hastingsae hastingsae* Alexander; 6, below, *Tipula* (*Lunatipula*) *hastingsae diperona*, n. subsp.; 7, *Tipula* (*Pterelachisus*) *macleani*, n. sp.; 8, *Tipula* (*Vestiplex*) *bergrothiana* Alexander; 9, *Tipula* (*Vestiplex*) *aldrichiana*; 10, *Limnophila byersi*, n. sp. Fig. 11. Male antenna of *Limnophila byersi*, n. sp. (Symbols: *a*, aedeagus; *b*, basistyle; *d*, dististyles; *g*, gonapophysis; *s*, sternite; *t*, tergite).

being *Tipula* (*Trichotipula*) *desertorum* Alexander, *T.* (*T.*) *dorsolineata* Doane, and *T.* (*T.*) *kennedyana* Alexander, all differing evidently in hypopygial structure, especially the dististyles.

Tipula (*Trichotipula*) *sanctaecruzae*, n. sp.

Allied to *beatula* and *capistrano;* head and thorax patterned with dark brown and yellow, mesonotal mediotergite with a narrow yellow central line; male hypopygium with tergal lobes truncate; appendage of ninth sternite including a long outer lobe, the lateral lobe low.

Male.— Length about 13 mm; wing 13.5 mm; antenna about 3 mm.

Female.— Length about 14-15 mm; wing 13 mm.

Frontal prolongation of head blackened, narrowly yellow on sides, ventrally more reddish yellow; palpi black. Antennae with scape light brown, tip paler, remainder of organ black; flegellar segments elongate. Head orange on sides, central part of vertex and occiput brownish black.

Pronotum brownish black. Mesonotal praescutum on disk with four brownish gray stripes broadly bordered by black, lateral margins of praescutum light orange; scutal lobes dark brownish gray, with a narrow central polished black line, median region light yellow; scutellum light yellow with a narrow central black line, parascutella black; postnotal mediotergite brownish black with a narrow median yellow vitta on anterior half, in cases this less distinct, anapleurotergite yellowed, katapleurotergite with central part restrictedly yellowed. Pleura brownish gray, patterned with yellow, more evident in certain individuals, including the dorsal sternopleurite, pteropleurite, and dorsal meral region. Halteres with stem yellow, base narrowly orange, knob brownish black, apex restrictedly yellowed. Legs with coxae brownish gray, trochanters yellow; femora brownish yellow, apices dark brown; tibiae brownish yellow, tarsi passing into black. Wings generally as in *beatula* and *capistrano*, differing only in minor details.

Abdomen with segments conspicuously patterned with brownish black and yellow, on tergites the dark color including posterior border and a broad central stripe. Male hypopygium (Fig. 5a) with ninth tergite, *t*, having lobes truncate, spinoid setae small and sparse, as shown; median region bordering emargination with abundant microscopic setulae. Appendage of ninth stèrnite, *s*, shaped as shown, including a major outer lobe provided with numerous chiefly marginal long twisted yellow setae, lateral lobe low. In *beatula* (Fig. 5c) tergite generally similar, appendage of ninth sternite, *s*, distinctive, with a slender lateral lobe, as shown. In *capistrano* (Fig. 5b) tergal lobes, *t*, more rounded; appendage of ninth sternite, *s*, distinctive, obtuse, outer lobe with abundant, very conspicuous, long, yellow setae.

Habitat.— California.

HOLOTYPE, ♂, Santa Cruz Island, Channel Islands, 3⅔ mi. to Devil's peak, ⅔ mi. to U.S.G.S. 1941, woodland, 4 April 1970 (Eric E. Remington). ALLOTOPOTYPE, ♀, 25 March 1970. PARATYPE, ♀, Santa Cruz Island, Cañada del Medio, at University of California Research Station, 18 April 1970 (Eric E. Remington).

The most similar species are *Tipula* (*Trichotipula*) *beatula* Osten Sacken and *T.* (*T.*) *capistrano* Alexander, all differing among themselves in hypopygial structure, especially the tergite and appendage of the ninth sternite, as discussed and figured.

In the California Bulletin concerning the crane flies, cited under the preceding species, there are only a few species recorded from the Channel Islands and several others were added in the collections made by the Remingtons, now preserved in the Peabody Museum. The determined species are here listed: *Nephrotoma wulpiana* (Bergroth), *Tipula* (*Bellardina*) *schizomera* Alexander, *Tipula* (*Triplicitipula*) *occidentalis* Doane, *Tipula* (*Triplicitipula*) *planicornis* Doane, *Tipula* (*Triplicitipula*) *pubera* Loew, *Tipula* (*Yamatotipula*) *fulvilineata* Doane, *Limonia* (*Dicranomyia*) *defuncta concinna* (Williston), *Limonia* (*Idioglochina*) *marmorata* (Osten Sacken), and *Erioptera* (*Trimicra*) *pilipes* (Fabricius).

Tipula (*Lunatipula*) *hastingsae diperona*, n. subsp.

MALE.— Length about 23 mm; wing 25 mm; antenna about 5 mm.

FEMALE.— Length about 23 mm; wing 20 mm.

General coloration much as in typical *hastingsae* Alexander (Bulletin Brooklyn Ent. Soc., 46:87-89; 1951), described from several stations in California, the detailed distribution being given in the Crane flies of California, as cited earlier, pages 43-44.

Size larger (male 25 mm; in *hastingsae*, 16-19 mm). Body and wing coloration generally similar in both subspecies. Chief differences found in the structure of the male hypopygium, especially the phallosome, as shown in the figures (*hastingsae*, Fig. 6 above; *diperona*, Figure 6 below). Gonapophyses, *g*, in the present fly with a powerful lateral spine at near midlength, lacking in *hastingsae*; aedeagus, *a*, with posterior spine at apex of organ very long and slender.

HABITAT.— California.

HOLOTYPE, ♂, Santa Cruz Island, Channel Islands, at University of California Research Station, Cañada del Medio, 18 April 1970 (Eric E. Remington). ALLOTOPOTYPE, ♀, 15 April 1970; Alexander Collection.

Tipula (*Pterelachisus*) *macleani*, n. sp.

General coloration of head and thorax gray, praescutum medially patterned with darker; antennae uniformly black; legs with femora brownish yellow, tips narrowly black, claws toothed; wings subhyaline, restrictedly patterned with very pale brown; abdomen

dark brown, in cases tergites 2-4 reddened; male hypopygium with central outer portion of tergite depressed to form a shallow yellow saucer, posterior margin with two approximated triangular points; eighth sternite with posterior border truncate, with inconspicuous pale setae.

Male.— Length about 12.5-13 mm; wing 12.5-13 mm; antenna about 4 mm.

Female.— Length about 17 mm; wing 12.5 mm; antenna about 3.5 mm.

Frontal prolongation of head black, gray pruinose; nasus conspicuous, with a terminal tuft of light yellow setae; palpi black. Antennae black throughout, scape sparsely pruinose; flagellar segments with small basal enlargements, exceeding verticils in length. Head light gray; anterior vertex more elevated, low, slightly infuscated; dorsal setae short, black, genae with long light yellow setae.

Pronotal scutum gray, sides of scutellum light yellow. Mesonotal praescutum light gray, with two intermediate brown stripes that narrow strongly behind, separated by a vaguely differentiated ground vitta, lateral stripes very pale to scarcely evident; median part of transverse suture dark brown; posterior sclerites of notum clear light gray; scutum with a narrow impressed median line, lobes slightly variegated with very pale brown; scutellum light gray with a vague central darkening, parascutella darkened anteriorly, behind narrowly light yellow; postnotum uniformly clear light gray. Pleura light gray, dorsopleural membrane restrictedly obscure yellow. Halteres with stem obscure yellow, brighter basally, knob small, brown, apex obscure yellow. Legs with coxae and trochanters light gray; femora obscure brownish yellow, tips narrowly black; tibiae light brown, tarsi darker brown; claw with a small acute point at near midlength. Wings (Fig. 2) subhyaline, very restrictedly patterned with pale brown, oval stigma darker; outer two-thirds of cell *M* chiefly very pale brown, this with a whitened area at near midlength; veins brown. Trichia on certain veins beyond cord, lacking on most of R_{1+2}, *Rs*, M_4 and *1st A* except at base, vein *2nd A* with extensive trichia. In paratype specimen, veins that comprise long cell *1st* M_2, with the exception of M_{3+4}, very pale to subobsolete, in the holotype these elements normally darkened. Venation: Petiole of cell M_1 about one-half *m*; distal section of Cu_1 strongly recurved at outer end narrowing the cell.

Abdomen of holotype with basal segment and outer five tergites dark brown, their posterior borders very narrowly yellowed, tergites 2-4 reddened, grayish sublaterally; all sternites dark brownish gray, posterior borders very narrowly yellow. Paratype male with abdomen uniformly dark brown. Female with tergites 2-7 chiefly reddened, outer segments darkened, sternites as in the male, the extreme bases of intermediate segments yellowed. Ovipositor with cerci long, straight, very slender; hypovalvae stouter, proximal half blackened, apices rounded. Male hypopygium (Fig. 7) with ninth tergite, *t*, dark brown, posterior median portion slightly depressed to

form a flattened yellow saucer, margin produced into two low submedian triangular points; setae of tergite pale, on darkened parts from tiny yellow punctures, vestiture of saucer small and pale, very inconspicuous. Dististyles, *d*, as shown; beak of inner style long and slender, blackened. Eighth sternite, *8s*, with posterior border truncate, vestiture pale, discal setae small, sparse marginal bristles only slightly longer.

HABITAT.— Alaska.

HOLOTYPE, ♂, Prudhoe Bay, 70° 18′ N. Lat., 148° 21′ W. Long., altitude 15 m, 24 June 1971 (Stephen F. MacLean); Field Catalogue No. 162; University of Kansas Collection. ALLOTOPOTYPE, ♀, with the type, 13 July 1971; No. 338. PARATOPOTYPE, ♂, July 1971; No. 228; Alexander Collection.

The species is named for the collector, Stephen F. MacLean, of the United States Biome Tundra Program. In its general appearance, including the hypopygium, the fly suggests various regional species of the subgenus *Vestiplex* Bezzi, especially *Tipula* (*Vestiplex*) *bergrothiana* Alexander (Fig. 8) and *T.* (*V.*) *aldrichiana* Alexander (Fig. 9), both from Alaska. The drawings of the male hypopygia of these two flies are based on the type specimens preserved in the United States National Museum. Other less similar Arctic American species include *Tipula hewitti* Alexander, *T. johanseni* Alexander, and *T. subpolaris* Alexander, of the Canadian Northwest Territory, and *T. katmaiensis* Alexander. From the structure of the ovipositor it appears that the present fly is correctly placed in the subgenus *Pterelachisus* Rondani.

Limnophila byersi, n. sp.

General coloration of body brownish gray, head light gray, anterior vertex broad; antennae of male approximately one-third length of body; legs with femora yellow, tips brownish black, tarsi black; wings brownish yellow, stigma oval, dark brown; cell R_2 at margin slightly less than one-half cell R_3; cell M_1 very small, from about one-fifth to one-sixth its petiole; male hypopygium with outer margin of basistyle with numerous very long setae, lobe of mesal face oval; outer dististyle narrowed on outer fourth, terminating in two small approximated points; phallosome with gonapophyses appearing as simple slender sickles, outwardly narrowed to an acute spine; aedeagus simple, long and slender, straight, nearly three times the apophyses.

MALE.— Length about 9 mm; wing 7.8 mm; antenna about 3.2 mm.

FEMALE.— Length about 12 mm; wing 9 mm.

Rostrum short and broad, transversely oval, dark brown, sparsely pruinose, with long whitish setae; palpi dark brown. Antennae of male (Fig. 11) long, nearly one-third the body; scape and pedicel dark brown, flagellum brownish black; flagellar segments with short dense pale setae and sparse longer bristles; intermediate fla-

gellar segments about 4-5 times as long as broad, verticils shorter than the segments; outer segments about three times as long as broad, subequal to their longest verticils; outer segment oval. Head light gray; anterior vertex very broad, about three times exposed diameter of eyes.

Pronotum brown, sparsely pruinose. Mesonotum almost uniformly brownish black, pruinose, praescutal stripes not differentiated; a single median black pit on praescutum, pseudosutural foveae larger, black; parascutella obscure yellow. Pleura gray; dorsopleural membrane obscure yellow. Halteres with stem yellow, knob small, weakly darkened. Legs with coxae and trochanters yellow; femora yellow, tips brownish black, on foreleg including about one-third the length, on posterior pair about one-fifth; tibiae brownish yellow, tips very narrowly darkened; tarsi black. Wings (Fig. 3) brownish yellow, base and costal region clearer yellow; stigma oval, dark brown; veins brown. Longitudinal veins beyond cord with black trichia, lacking on veins comprising cell *1st* M_2; further trichia on Rs, outer third of basal section of Cu_1, and on most of *2nd A*. Venation: cell R_2 at margin slightly less than one-half cell R_3; cell M_1 very small, about one-fifth to one-sixth its petiole; *m-cu* shortly beyond one-third M_{3+4}.

Abdomen brownish black, sparsely pruinose, including the hypopygium. Ovipositor with valves stout, cerci obscure yellow, hypovalvae black. Male hypopygium (Fig. 10) with basistyle, *b*, stout, outer margin thickened, with numerous very long setae, longest about one-half outer dististyle; cephalic end of mesal face with an oval lobe provided with long pale setae. Outer dististyle, *d*, glabrous, gently curved, outer fourth narrowed, terminating in two small approximated points, axial one stouter; inner style with base stout, with conspicuous setae, outer half narrowed, setae microscopic. Phallosome with gonapophyses, *g*, appearing as slender simple curved sickles, narrowed gradually into an acute spine; aedeagus simple, very long and slender.

Habitat.— Alaska.

Holotype, ♂, Prudhoe Bay, 70° 18′ N. Lat., 148° 21′ W. Long., altitude 15 m, June 1971 (Stephen F. MacLean); No. 345. Allotopotype, ♀, with type; No. 298. Paratopotype, ♂, with types.

The species is named for my long time friend and fellow student of the Tipulidae, Dr. George W. Byers, of the University of Kansas. The closest regional ally is *Limnophila poetica* Osten Sacken, widely distributed in northern North America, from Massachusetts to British Columbia, thence north to Alaska. This is readily told from the present fly by the yellow body coloration, longer antennae, venation, especially the normal cell M_1, and in details of the male hypopygium, including the basistyle, and the gonapophyses and aedeagus of the phallosome. The microscopically bidentate apex of the outer dististyle is found in both species.

NEARCTIC DESERT DECTICIDAE (ORTHOPTERA) PART III THE TRUE TYMPANUM IN CERTAIN GENERA WITH KEY

Ernest R. Tinkham[1]

This is a report on the nature of the true tympanum in Decticidae, its location and taxonomic value. The decticids are a most difficult group to evaluate generically, and any new character that will aid in defining and keying out genera should be of definite taxonomic value in addition to adding to our knowledge on sound reception in these most interesting creatures.

Apparently no recognition has been given in the literature to the location and character of the true tympanum in the Decticidae or related Tettigonoidea or in the Oecanthidae or other orthopteroid families. Textbooks have for many decades illustrated and described the tympanum as located in the basal portion of the protibia where there is a small, hollow, swollen area with internal and external longitudinal slots that are supposed to permit the entrance of sound vibrations. All members of the Tettigonoidea that stridulate are supposed to possess this protibial organ.

Fulton (1928) conducted experiments on certain tettigoniids, including *Neoconocephalus nebrascensis*, *Amblycorypha rotundifolia brachyptera*, and *Oecanthus niveus*, in which half of his caged specimens had their fore tibiae amputated at their bases; the checks were normal. His experiments proved that those with amputated protibiae could still hear but that an asynchronization had developed, while in the control or untreated cages synchronization of stridulation to distant stridulating males proceeded normally. These experiments indicated that tettigoniids and oecanthids with snipped-off fore tibiae could still hear, but the obvious meaning was obscured. Fulton summarized his conclusions thus: "The tympanal organs of the front tibiae are auditory organs, an assumption based on circumstantial evidence of their structure and the fact that they are present in all stridulating species."

It is obvious that such an assumption can be erroneous. It is like amputating the arms but not observing the ears which hear. Certainly, decticids, tettigoniids, oecanthids, and others can still hear sound, even with their front legs cut off, because the tympana are present on the thoraces of these creatures.

Snodgrass (1925) states that "if they [protibial organs] are not ears what are they?"

Such assumptions and conclusions can explain the oversight in recognizing the true tympanum. Obviously, the protibial organ in the decticids, tettigoniids, and oecanthids, as shown by Dr. Fulton's experiments, must be a substation or synchronometer that interprets and passes on the sound received by the true tympanum, herein de-

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scribed as located on the thorax, and flashes on a response to the tegmina, which stridulate their challenge to the producer of the received sound or song.

That the organ which lies just caudad of the prothoracic spiracle is the tympanum is further corroborated by the position of the tympanum in all those sound-producing acridids in many subfamilies of grasshoppers, where its location is just caudad of the metathoracic spiracle and only two segments removed from that in the Decticidae and just above the metacoxal joint of the hind leg.

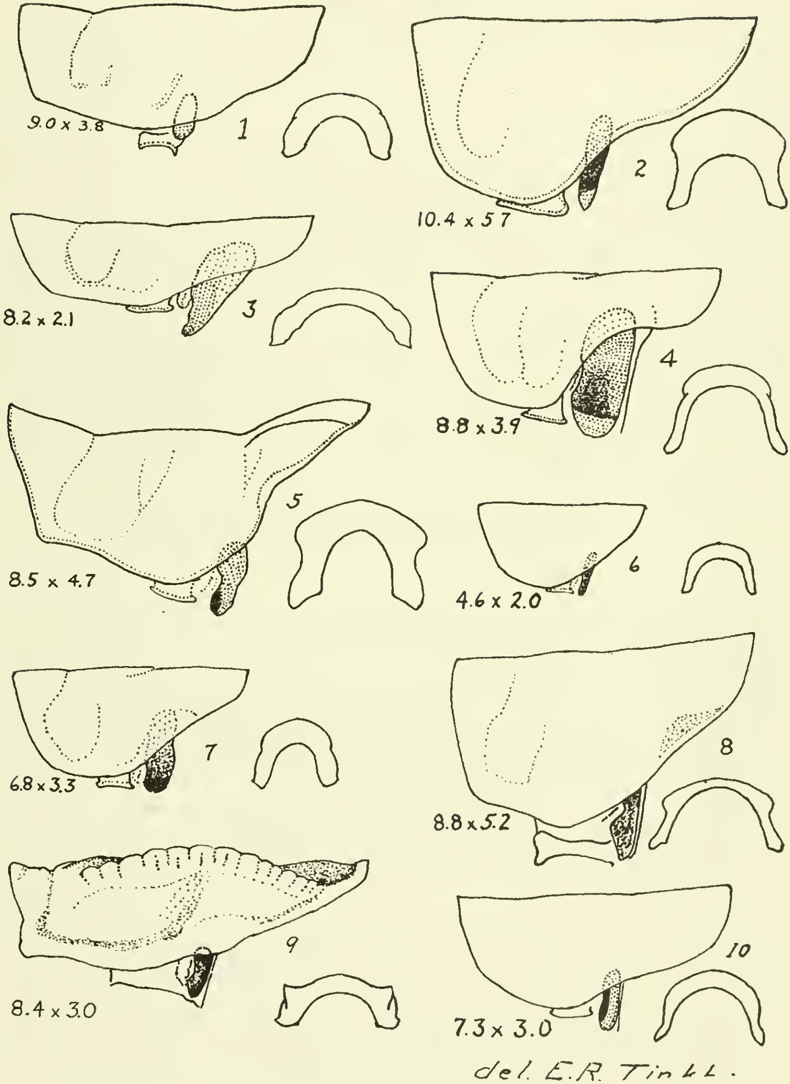
It is interesting to note that the two new genera recently described by the author, namely, *Petropedes* and *Platyoplus*, portray the greatest development of the tympanum, but nature exhibits two different ways to increase the receptivity of sound. In *Platyoplus* (Figure 3) though the pronotum is very broad and very shallow, it still hides half of the very large, auricular-shaped tympanum. To overcome this effect, the pronotum just above the covered upper portion of the tympanum at the posteroventral emargination of the lateral lobes is convexly swollen to facilitate the penetration or reception of sound. On the other hand, in *Petropedes* (Figure 4) although the lateral lobes are very deep, the posteroventral margin is more strongly emarginate or excised than in any other eremicolous decticid genus, so that the huge tympanum is almost completely exposed for the reception of sound.

Although both genera possess a very large tympanum, relationship stops at this point; for the two genera represent two different sections of the Decticidae. *Platyoplus* apparently has its nearest relationships with *Ateloplus*, especially the largest species *A. splendidus*, whereas *Petropedes* seems allied to *Inyodectes* and perhaps *Eremopedes* and *Pediodectes* as well.

Likewise, it is interesting to note that both recently described genera inhabit barren, inhospitable rocky mountain slopes under a blazing sun, and the enormous tympana would appear to be adaptions to such an environment. *Inyodectes* (Figure 7) seems to bear out this observation, for it also has a relatively large tympanum in relationship to its medium size. Although it does not dwell in such a hot desert as *Petropedes* and *Platyoplus*, which are both members of the fauna of the hottest desert, the Colorado, it does dwell in piles of rocks at the base of talus slopes in the western portions of Westguard Pass at about the lower limits of the pines in the Inyo Mountains, which likewise, because they lie in the rainshadow of the Sierra Nevadas, are very barren and xeric.

In *Ateloplus* (Figure 1), a review of the known species shows that the tympanum is oval in shape and not as large or expanded in its upper half as in *Platyoplus*. In *Ateloplus*, the species *A. schwarzi* and *A. notatus* show tympana that are roundly oval in shape; whereas in *A. hesperus*, *A. luteus*, *A. minor*, and *A. splendidus*, the tympana are more narrowly elliptical in relationship to their size.

In *Eremopedes* (Figures 2, 10), the tympana range from a narrow elliptical slit in *E. shrevei*, *E. balli*, *E. covilleae*, *E. ephippiata*,



Figs. 1-10. Decticid pronota as seen in lateral aspect and cross-sections from cephalic aspect: 1, *Ateloplus splendidus*, male topotype; 2, *Eremopedes ephippiatus sonorensis*, male holotype; 3, *Platyoplus gilaensis*, holotype; 4, *Petropedes santarosa*, holotype; 5, *Capnobotes fuliginosus*, male, Mulligan Canyon, Franklin Mts., Texas; 6, *Oreopedes cryptoptera*, female, Westguard Pass; 7, *Inyodectes pallidus*, female topotype, Westguard Pass; 8, *Zacycloptera atripennis*, topotype, Walker Lake, Nevada; 9, *Plagiostira utahensis*, female, western Utah; 10, *Eremopedes bilineatus*, male, Santa Ana, Sonora, Mexico.

and *E. pallidus* to a narrowly oval form in *E. bilineatus*, *E. scudderi*, and *E. ephippiata sonorensis*.

In most of the other genera, such as *Oreopedes* (Figure 6), *Capnobotes* (Figure 5), *Zacycloptera* (Figure 8), *Plagiostira* (Figure 9), *Neduba*, and *Aglaothorax*, the tympana are rather oval elliptical, and some of these, especially *Zacycloptera*, *Plagiostira*, and *Capnobotes*, have the fore margin of the tympanum quite irregular due to the presence of the prothoracic spiracle.

Another feature of the tympanum that should be noted here is whether its periphery is bare or lined with an even row of very fine, short-tapered hairs. In *Platyoplus*, *Petropedes*, *Inyodectes*, *Capnobotes*, and *Anoplodusa*, the peripheral margin is barren of any minute hairs; in *Ateloplus*, the margin is very finely hirsute in the smaller species but bare in *A. splendidus*, the largest species; in *Oreopedes*, the margin is very finely hirsute; in *Eremopedes*, it is barren in some species and hirsute in others. The function of these hairs is not known or surmised at this time; a study of their function and structure would be most interesting and perhaps revealing.

Key to Certain Eremicolous Genera Based on Tympana and Pronota

1. Tympanum extremely large, located at or near sinuation of posteroventral margin of lateral lobes of pronotum 2
   Tympana mostly medium to small in size 3

2. Tympanum enormous, broadly oval, and largely exposed by strongly excavate posteroventral emargination of pronotum, although upper quarter still concealed .... *Petropedes*
   Tympanum very large, auricular in outline, largely concealed by very broad, very shallow lateral lobes of pronotum; pronotum convexly swollen above concealed portion of tympanum .... *Platyoplus*

3. Pronotum barrel-shaped, without lateral carina 7
   Pronotum with partial or complete rounded lateral carinae 4

4. Pronotum extremely large, ovally rounded in dorsal outline, its dorsal surface gently convex 5
   Pronotum not as above, more narrowly linear, sometimes quadrate in dorsal outline; dorsal surface irregular 6

5. Pronotum extremely large, oval in dorsal outline, highly colored .... *Aglaothorax*
   Pronotum moderately large, colored more drably .... *Neduba*

6. Size very large; tegmina and wings far surpassing apex of abdomen; metazona with strongly arched lateral ridge or keel .... *Capnobotes*

Size large, tegmina and wings slightly longer than pronotum; lateral carina of pronotum crenulate-arcuate; disc of pronotum irregular .... *Plagiostira*

7. Size very small .... *Oreopedes*
   Size medium to larger 8

8. Body large and heavy; wings jet black; tegmina and wings slightly longer than pronotum .... *Zacycloptera*
   Body much more slender, wings not black; tegmina and wings shorter than pronotum 9

9. Tympanum relatively large for medium size and half exposed .... *Inyodectes*
   Tympanum small, usually oval elliptical; size ranging from small to large 10

10. Size mostly medium to large, mostly heavy bodied; pronotum with deep lateral lobes .... *Eremopedes*
    Size medium large to small; pronotum broad, with disc convex and with rather shallow lateral lobes .... *Ateloplus*

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NOTES ON REPRODUCTION IN *LAMPROPELTIS TRIANGULUM* AND *COLUBER CONSTRICTOR* IN UTAH

William L. Grogan[1] and Lloyd C. Pack, Jr.[2]

A search of the literature has revealed no published records of egg laying in *Lampropeltis triangulum taylori* Tanner and Loomis. On 8 July 1967 a female with a snout-vent length of 494 mm was collected in Hobble Creek Canyon, 7 mi. east of Springville, Utah. On 20 July four eggs were laid. After four weeks of incubation the eggs were attacked by fungi and were discarded.

Van de Velde, Martan, and Risley (1962) first described the hatching of eggs of *Coluber constrictor mormon* Baird and Girard. Since then no other hatchings have been recorded. On 12 July 1967 one male and three gravid females were collected at the same locality as above. Clutches of seven eggs were laid on 21 July, six on 24 July, and six on 28 July. The eggs were placed on moist sand in a jar for incubation. The last laid clutch was discarded because of fungi. Two eggs of that clutch were dissected and found to contain embryos. Two eggs of the first clutch hatched on 26 September and five on 27 September. Three eggs of the second clutch hatched on 1 October and one on 3 October. The remaining two eggs in this clutch did not hatch. The time of hatching varied from 67 to 70 days, with eight of the eleven hatching in 68 days.

The color pattern of our specimens was similar to that described by Van de Velde, Martan, and Risley (1962); however, there were a few important differences. The dorsal saddles ranged from 46 to 51 as compared with their 69. The chin, throat, infralabials, and supralabials are a vivid white with dark reddish brown spots on the posterior margins of the supralabials and the last infralabial. The color of the head also differs in that the ground color is light gray brown with darker brown spots on the prefrontals, supraoculars, frontal and parietals.

Four of the hatchlings are preserved in collections of Brigham Young University (BYU 30808-30811). Their respective snout-vent and total lengths in mm are: 192-263, 222-284, 202-280, 201-274.

We are indebted to Wilmer W. Tanner and Dorald M. Allred for criticism of the manuscript.

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COURTSHIP BEHAVIOR AMONG WHITE-TAILED AND BLACK-TAILED JACKRABBITS

Del F. Blackburn[1]

This paper represents a portion of a research project on behavior of black-tailed and white-tailed jackrabbits, *Lepus californicus* and *L. townsendii*, of the Castle Rock area of Eastern Oregon. The full study is described elsewhere (Blackburn, 1968).

The observations made of jackrabbit courtship behavior from April through July, 1967-68 were quite similar to those described by Severaid (1941), Janson (1946), Lechleitner (1959), Haskell and Reynolds (1947), and Pentrelli (1968).

I observed both white-tailed and black-tailed jackrabbits in varying habitat and behavioral situations. This provided the opportunity to extend many of the reports just mentioned.

Both Pentrelli and Lechleitner reported black-tailed jackrabbits as having very intense courtship behavior involving circling, male and female approaches, and long chases. In this study urine emission was observed during the jumping and chasing activity. This complex behavior involving combinations of all the above listed components was observed to last from 5 to 20 minutes. Copulation usually followed. After copulation the male jackrabbit was observed on several occasions to jump slightly backwards, fall to the ground, emit a hissing squeal and leap up again renewing the chase with subsequent copulations of up to four times.

Although only a few observations of courtship among white-tailed jackrabbits were possible in this study, their courtship behavior was observed to be basically the same as that of black-tailed jackrabbits, with the exception that jumping behavior was more pronounced.

Tinbergen (1952) states that displacement behavior is caused or motivated by a surplus of stimulus or drive. A jackrabbit, highly excited during escape or reproductive behavior, may exhibit this type of activity. I observed five male black-tailed jackrabbits in pursuit of one female. After sighting me, two of the males left the pack and began feeding. They fed vigorously and did not attempt to leave the area upon my approach. Shortly afterwards, two other males abandoned the female and began attempting to copulate with each other. Upon collection, both had their penises fully extended. Both of these behavior types suggest a displacement type of behavior. A single remaining male was observed to copulate twice with the female. The entire area surrounding this field of activity was covered with hair, the presence of which suggested fighting.

I thank the Bureau of Land Management, Vale, Oregon, for their support of this study. It was conducted under the guidance of the Department of Zoology, University of Idaho, Moscow, Idaho.

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LOCAL DISTRIBUTION AND INTERSPECIES INTERACTIONS IN MICROTINES, GRAND TETON NATIONAL PARK, WYOMING

Tim W. Clark[1]

Abstract.— Some ecological relationships and interspecies interactions (i.e., habitat, foods, and reproduction) between *Microtus pennsylvanicus pullatus*, *M. montanus nanus*, *M. longicaudus mordex*, and *Clethrionomys gapperi galei* were investigated in Grand Teton National Park, Wyoming. Trapping was conducted from June-July, 1968 and May-July, 1969 yielding 110 *M.p.p.*, 171 *M.m.n.*, 17 *M.l.n.* and 41 *C.g.g.* Six plant communities were defined structurally; all communities contained voles but varied considerably in numbers of species and individuals. Analyses of stomach contents showed similar diets. Embryo counts indicated that there was no significant interspecies differences in litter sizes. Females of all species were pregnant in about equal proportions. Almost all adult males showed descended testes and were reproductively active. Testicular and seminal vesicle weights and lengths fluctuated. *M.p.p.* mean body weights were largest: M44.7g (N=31), F38.1g (N=29); this was nearly twice the mean weights of *C.g.g.*: M20.4g (N=7), F23.3g (N=3). Weights for *M.m.n.* and *M.l.m.* fell between these extremes and were similar to each other. Trends in differential habitat use were clearly demonstrated and evidence suggests the four microtines are at least partially incompatible.

Four common rodents in Grand Teton National Park are: *Microtus pennsylvanicus pullatus* (meadow vole), *M. montanus nanus* (mountain vole), *M. longicaudus mordex* (long-tailed vole), and *Clethrionomys gapperi galei* (red-backed vole). Except for Findley (1951 and 1954), Negus and Findley (1959), and Stoecker (1970), little is known on distributions and ecology of these four species in the park. It is well documented that population levels are directly linked with relative numbers of other species in the community (Wirtz and Pearson, 1960; Curry-Lindahl, 1959; DeLong, 1966; Lidicker, 1966; Whitaker, 1967; Batzli, 1968; Shure, 1970). This paper further elucidates some ecological relationships and interspecies interactions (i.e., habitat, food habits, and reproductive characteristics) between these microtines in Grand Teton National Park, Wyoming.

Methods

The study was conducted in June and July, 1968, and May through July, 1969. A total of 339 specimens were collected: 171

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Microtus montanus, 110 *M. pennsylvanicus*, 17 *M. longicaudus*, and 41 *Clethrionomys gapperi*. Sherman live traps and snap traps were used, and each trapline (1 trap every 10 meters) was left for 3 to 6 days, then moved to a new site. Traplines ranged from 25 to 50 traps each. For each Sherman trapline set, two snap traplines were set in each community. Thus the relative proportion of live traps to snap traps was uniform between communities.

Table 1 summarizes the six lowland plant communities trapped to determine habitat affinities. More detailed descriptions are given by Clark (1971) and Reed (1952).

Food uses were ascertained by stomach content examination. Contents were identified and a volumetric estimate made to the nearest 5 percent for each item. The mean volumetric estimates and frequencies of occurrence of each item were calculated (Clark, 1968).

In the field, all males were checked for position of testes; females were examined for condition of mammae (relative prominence and possible lactation). In the laboratory, male reproductive systems were removed; testes and seminal vesicles were examined, weighed, and measured. In the females, the number of embryos was counted.

Table 1. Comparison of plant communities sampled for microtines in Grand Teton National Park, Wyoming.

Plant Community	Prominent Species	Characteristics
1. Sedge-Meadow	*Carex* spp. *Aleopecurus aequalis* *Hordeum bachyantherum*	Underlain by firm sod; often covered with several cm of water; no woody plants, only sedges, grasses, and forbs
2. Sedge-Grass Meadow	*Carex* spp. *Agropyron trachycaulum* *Bromus*, *Poa*, *Agrostis*	Slightly elevated ground: very productive, 30 spp. of forbs; no woody plants, only sedges, grasses, and forbs; rarely covered by water
3. Shrub-Swamp	*Salix* sp. *Bromus*, *Poa*, *Calamagrostis*, *Aster*, *Aconitum*, *Castelleja*, *Ranunculus*	Water table near surface; stable; reduced light intensity under shrubs along with increased moisture; woody plants-shrubs, sedges, grasses, and forbs; shrubs over 50 percent ground cover
4. Shrub-Sedge-Grass Savanna	Same as (3) above	Shrubs less than 50 percent ground cover
5. Aspen	*Populus*, *Aster*, *Helianthella*, *Lupinus*	More level sites adjacent to swamps and meadows; closed tree canopy, dense shade; soil moist in spring but diminishes in summer
6. Big Sagebrush	*Artemisia*, spp., *Purshia* *Stipa*, *Poa*, *Bromus*, *Aster*, *Eriogonum*, *Potentilla*	Most widespread and conspicuous community; shrubs, forbs, and grasses; very dry, little to no water

Measurements of tail, hind foot, and total lengths and body weights were taken on all specimens. All *M. pennsylvanicus* and *M. montanus* were identified on the basis of molar structure. Representative specimens were prepared as museum skins and deposited in the Jackson Hole Biological Research Station collection and in the Museum of Natural History, University of Wisconsin-Stevens Point.

Results

Habitat affinities.— Habitat affinities were based on the plant communities in which capture per species was greatest (Maxell and Brown, 1968). All communities contained voles but varied considerably in numbers of species and individuals (Figure 1). Two communities (Sedge-Meadow and Sedge-Grass Meadow) were exclusively occupied by *M. montanus*, while the other four communities showed multispecies occupancy. The Big Sagebrush Community yielded only two species (*M. montanus* and *M. pennsylvanicus*), the Shrub-Swamp Community three species (all but *M. longicaudus*), and the Shrub-Sedge-Grass Savanna and Aspen Communities all four microtine species.

M. montanus was found in all six plant communities, its population numbers exceeding *M. pennsylvanicus* (the second most abundant species) in all communities except the Shrub-Swamp, where *M. pennsylvanicus* greatly outnumbered other voles. *M. pennsylvanicus* showed the second widest distribution in four communities. *Clethrionomys gapperi* occupied three plant communities and *M. longicaudus* only two (Figure 1).

Five of the six plant communities (excluding Big Sagebrush) are in successional sequence on the wetter sites in Jackson Hole (Reed, 1952). Some general characteristics of these communities in relation to vole distribution are given in Figure 1. The closer the plant community to climax, the greater the vole species diversity [species diversity refers to the number of species in each community (M'Closkey, 1972)]; correlated to this is a trend toward mesic soil-moisture conditions and more complex plant community structure (i.e., potentially more niches). The Aspen Community, the highest seral community of the sequence, possessing mesic soil-moisture conditions and three vegetative strata (herbs, shrubs, and trees), contained all four microtines. The simpler the community structurally—by virtue of its early successional position (Sedge-Meadow or Sedge-Grass Meadow) or limited moisture (Big Sagebrush)—the smaller the species diversity, one and two species, respectively.

However, the greatest species diversity was not correlated with greatest total populations numbers. The Shrub-Swamp Community is characterized by only two vegetational strata (herbs and shrubs), a 50-100 percent ground cover of shrubs, and some areas inundated by several cm of standing water; it is located near the middle of the successional sequence. It was this community that showed the greatest absolute numbers of voles (N=117) and the greatest CI,

	Herbs	Herbs	Shrubs Herbs	Shrubs Herbs	Trees Shrubs Herbs	Shrubs Herbs
	Wet - Moist		Wet	Moist		Dry
	Generalized Hydrosene Succession					
Microtus longicaudus				0.1 (N=2)	0.7 (N=15)	
Clethrionomys gapperi			1.8 (N=26)	0.1 (N=2)	0.6 (N=13)	
Microtus pennsylvanicus			6.5 (N=90)	0.7 (N=11)	0.3 (N=7)	0.1 (N=2)
Microtus montanus	3.1 (N=53)	3.5 (N=60)	0.1 (N=1)	1.8 (N=30)	0.7 (N=16)	0.7 (N=11)
	Sedge-Meadow (1,704)	Sedge-Grass Meadow (1,595)	Shrub-Swamp (1,380)	Shrub-Sedge-Grass Savanna (1,653)	Aspen (2,071)	Big Sagebrush (1,633)
	PLANT COMMUNITIES					

Fig. 1. Distribution of some microtines in Grand Teton National Park, Wyoming, in relation to plant communities and their characteristics. Numbers in blocks are capture indices (i.e., captures per 100 trap days) and those below plant community names are trap days.

with almost twice the total catch as the second highest community (N=60). Nearly all voles in this community were *M. pennsylvanicus*. Population numbers were more or less comparable among the Sedge-Meadow, Sedge-Grass Meadow, Shrub-Sedge-Grass Savanna, and Aspen Communities, with a CI (captures per 100 trap days) of .031, .037, .027, and .025, respectively. The Big Sagebrush Community, a dry community, showed the lowest total population number (N=13) and a CI of only .008, over 90 percent lower than the most populous community (Shrub-Swamp, with N=117).

In the two communities where *M. montanus* was most abundant, other species were absent. The community where *M. montanus* was almost totally absent was the community showing the largest numbers of both *M. pennsylvanicus* and *C. gapperi*. The *C. gapperi* were situated on drier sites in peripheral areas of this community, and *M. pennsylvanicus* tended to occupy wetter areas. The driest community yielded two species, with *M. montanus* outnumbering *M. pennsylvanicus* seven to one. In the two communities containing all four microtines, the numbers of all species were considerably less than in communities that were occupied by only one, two, or three species. In all six communities, for every 10 *M. montanus* taken, 7.5 *M. pennsylvanicus*, 2.5 *C. gapperi*, and 1 *M. longicaudus* were captured.

Stomach contents.— Among the more obvious possibilities for competition between species is maintenance of adequate levels of energy and nutrition for meeting metabolic requirements. Analyses of stomach contents showed a similar diet in the four microtines (Table 2). Green plant materials comprised the major identifiable items in all stomachs; seed fragments were the other important food. The herbivorous habits of all species suggest potential competition for food, at least during seasons when food may be scarce. During the months of this study, food was abundant and did not seem to influence distributions.

Microtus montanus and *M. pennsylvanicus*, the two species probably most directly in competition, showed comparable levels of

Table 2. Comparative stomach contents of some microtines in Grand Teton National Park, Wyoming. Figures are mean volumetric estimates calculated to the nearest 1 percent; figures in parentheses are percent frequencies of occurrence; T indicates trace.

Stomach Contents	*Microtus montanus* (N=139)	*Microtus pennsylvanicus* (N=107)	*Microtus longicaudus* (N=14)	*Clethrionomys gapperi* (N=25)
Green plant materials	63(80)	94(80)	38(55)	59(76)
Seed fragments	8(13)	1(9)	1(1)	9(19)
Arthropods	T(1)			
Parasitic roundworms	4(8)	2(6)		
Hair				6(18)
Unidentified	25(100)	3(100)	61(100)	26(100)

parasitic roundworm infestations. Both *M. longicaudus* and *Clethrionomys gapperi* lacked worms. The infested voles otherwise looked healthy; the parasitic load did not seem to be responsible for any observable mortality.

Reproduction.— Differential reproduction may greatly enhance the competitive advantage of one species over another. The breeding status of females of the four microtine species is given in Table 3. Embryo counts indicated that there was no significant interspecies difference in litter sizes. The percentage of pregnant adult females in all species was similar except for *Clethrionomys gapperi*, which showed a pregnancy rate about one-half that of the other three. Throughout May, June, and July, females of all species were pregnant in about equal proportions, indicating continuous breeding activity of the population during this time.

Almost all adult males of the four species showed descended testes; males with scrotal testes are frequently used as an indication of population breeding (Packard, 1968). The mean testicular lengths and weights and mean seminal vesicle lengths and weights varied over the periods of study for all four species (Tables 4 and 5). Figure 2 shows testis lengths in millimeters and weights in milligrams for the four microtines. A sharp increase in lengths and weights was evident in *Microtus montanus* from June 16 to 30, corresponding to a slight decrease in the other three species. The relationship was not clear. In the other three microtines, testes parameters were more or less stable, showing no such sudden increase or decrease. Seminal vesicles showed a pattern of weights and lengths corresponding with that of testicular weights and lengths (Figure 2). The mean seminal vesicle parameters for *M. montanus* again increased sharply in late June, corresponding to the increase in testes size. The mean seminal vesicle length in *M. longicaudus* increased slightly during the same period (June 16-30), but a concomitant increase in seminal vesicle weights was absent. Testicular and seminal vesicle characteristics in *C. gapperi* showed no peak of activity, perhaps indicating a constant level of spermatogenic activity.

Morphological characteristics.— Relative body size may be significant in determining the outcome of agonistic interactions and, thus, species distributions. The four microtines varied in morphological characteristics (Table 6). *Microtus pennsylvanicus* mean weights were largest: males 44.7 g, females 38.1 g; this was nearly

Table 3. Comparative female reproductive statuses of four microtines, Grand Teton National Park, Wyoming.

Reproductive Characteristic	*Microtus montanus*	*Microtus pennsylvanicus*	*Microtus longicaudus*	*Clethrionomys gapperi*
Total number examined	50	46	4	11
Number pregnant	40	32	3	4
Mean number of embryos	6.35	6.59	6.00	6.00
Range in embryo number	4-9	4-9	5-7	4-7
Standard deviation	±1.29	±1.34	±1.16	±1.19

TABLE 4. Testis weights in mg and testis lengths in mm for four microtine species in Grand Teton National Park, Wyoming.

Periods	N	Mean	Range	S.D.	Mean	Range	S.D.
	Testis Weights (mg)				Testis Lengths (mm)		
			Microtus montanus				
May 15-31	6	680	526-729	±124	13.0	9-15	±2.86
June 1-15	7	535	261-676	±101	10.8	9-12	±0.80
June 16-30	11	1449	850-1818	±420	15.7	13-18	±2.06
July 1-15	9	535	500-570	± 35	10.7	10-12	±0.50
July 16-31	12	586	497-621	±321	11.8	9-14	±1.26
Total	45						
			Microtus pennsylvanicus				
May 15-31	10	1225	731-1185	±159	15.1	13-17	±1.27
June 1-15	10	1389	568-1849	±322	15.7	11-18	±1.81
June 16-30	7	6274	967-1501	±173	14.0	13-16	±1.73
July 1-15	8	1275	1060-1495	±178	15.0	14-17	±1.22
July 16-31	11	1190	1136-1238	±192	14.8	13-16	±1.64
Total	46						
			Microtus longicaudus				
May 15-31	3	541	436-582	± 89	12.0	11-13	±1.0
June 1-15	3	679	610-694	± 47	12.0	11-13	±1.0
June 16-30	4	535	489-569	±110	10.0	9-11	±0.8
July 1-15	4	587	502-621	±126	10.0	9-11	±0.8
July 16-31	1	610	—	—	11.0	—	—
Total	15						
			Clethrionomys gapperi				
May 15-31	4	364	330-380	± 23	9.7	9-10	±0.50
June 1-15	3	366	287-410	±218	10.0	—	—
June 16-30	5	409	362-440	±167	9.2	8-11	±1.09
July 1-15	5	318	289-354	±148	10.6	10-12	±0.89
July 16-31	3	392	—	—	9.3	9-10	±0.57
Total	20						

twice the mean weights of *Clethrionomys gapperi:* males 20.4 g, females 23.3 g. Weights for *M. montanus* and *M. longicaudus* fell between these extremes and were similar to each other.

The linear measurements of *C. gapperi* and *M. montanus* were similar, both smaller than the other two microtines. Even though *M. pennsylvanicus* had the largest body weight, its length was exceeded by that of *M. longicaudus. M. longicaudus* total and tail lengths are greatly expanded by its disproportionately long tail.

Discussion

Animal distributions are influenced by a constellation of factors ranging from a complex of abiotic environmental gradients to biotic regulators including diseases, predators, and intra- and interspecific competition. The importance of these factors varies from area to area; it is difficult to dissect out each factor and determine its relative influence in controlling population distributions and numbers. This study examined some aspects of the environment as well as the relationship of other species in the community to distributions of some microtines. Distribution patterns suggest that some mecha-

TABLE 5. Seminal vesicle weights in mg and lengths in mm for four microtine species in Grand Teton National Park, Wyoming..

	Seminal Vesicle Weights (mg)				Seminal Vesicle Lengths (mm)		
Periods	N	Mean	Range	S.D.	Mean	Range	S.D.
			Microtus montanus				
May 15-31	6	379	286-399	± 69	19.0	14-22	±1.97
June 1-15	7	359	262-420	± 73	16.3	14-19	±1.38
June 16-30	11	824	270-1153	± 89	23.7	15-29	±6.18
July 1-15	9	364	287-435	± 61	17.2	14-20	±2.54
July 16-31	12	342	268-411	± 89	18.2	14-21	±3.16
Total	45						
			Microtus pennsylvanicus				
May 15-31	10	484	325-760	±118	20.1	17-24	±1.89
June 1-15	10	733	316-1210	±281	22.1	14-26	±3.45
June 16-30	7	623	410-875	±179	20.5	17-23	±2.51
July 1-15	8	936	561-1420	±357	20.5	17-24	±2.89
July 16-31	11	782	528-926	±286	20.7	17-22	±2.44
Total	46						
			Microtus longicaudus				
May 15-31	3	340	289-390	± 51	12.3	11-14	±1.53
June 1-15	3	205	176-256	± 44	14.0	13-15	±1.00
June 16-30	4	240	210-314	± 94	17.0	14-18	±2.00
July 1-15	4	320	286-354	± 72	14.0	13-16	±1.41
July 16-31	1	280	—	—	14.8	—	—
Total	15						
			Clethrionomys gapperi				
May 15-31	4	230	100-251	± 62	16.0	14-17	±1.50
June 1-15	3	235	140-252	± 72	15.0	14-16	±1.00
June 16-30	5	210	126-246	±117	15.4	15-16	±0.55
July 1-15	5	279	224-343	± 69	14.6	13-17	±1.52
July 16-31	3	261	242-289	± 24	16.0	15-17	±1.00
Total	20						

nism of active separation is operative, especially between *Microtus montanus* and *M. pennsylvanicus*. Some of the habitats contained multiple species, while others only one. In the habitats containing one species, interspecific relations may be a factor keeping other species out. In situations where two or more species occur, competition is probably occurring. As discussed by Whitaker (1967) when competition is great enough one or both species may tend to reduce the population of the other species. Then we would expect to find lower population numbers in areas where both species occur than in situations where only one species is found. Grant (1970a) concluded from a series of laboratory studies supported by fieldwork (Grant, 1969, 1970b) that when adults of two species that normally occupy different habitats in mainland regions meet in the wild they will interact aggressively and tend to disperse. This habitat segregation is maintained on islands where both genera *(Clethrionomys* and *Microtus)* are represented by at least one species; but on islands where only a single species of one of the genera occurs, it often occupies the habitat of the absent genera (Ota and Jameson, 1961;

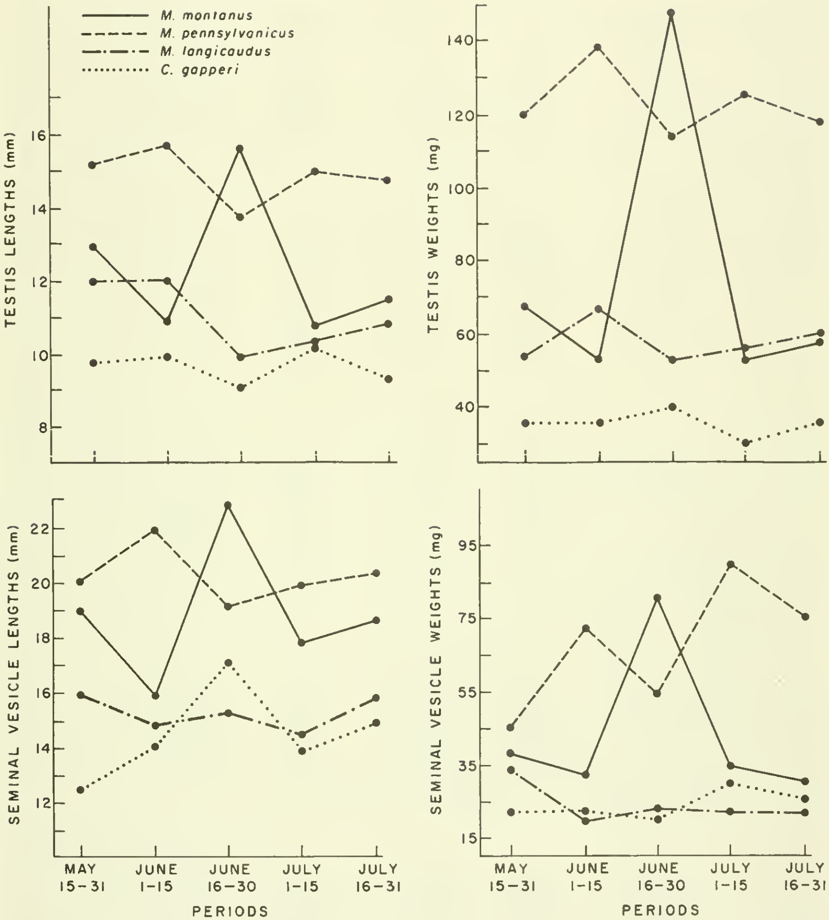

Fig. 2. Changes in testis lengths (mm) and weights (mg) and seminal vesicle lengths (mm) and weights (mg) for four microtines, Grand Teton National Park, Wyoming.

Cameron, 1964; Corbet, 1964). This implies some form of population interaction in areas of sympatry.

Ecological segregation in my study could be a result of each species responding to microenvironmental requirements and may not be related to other species in the community. Whereas several of the plant communities sampled in this study are very similar and since the four microtines are closely related taxonomically, it is likely that they share some similar ecological requirements; therefore, distributions exhibited are probably the result of competition for these requirements. When few or no ecological differences are present between two or more species occurring together, and

Table 6. Comparison of body lengths in mm and body weight in gm between four microtines, Grant Teton National Park, Wyoming.

Species	Morphological Characters				
	Total Length	Tail Length	Ear Length	Hind Foot Length	Body Weights
	X Range	X Range	X Range	X Range	X Range
Microtus pennsylvanicus					
♂ (N=31)	165.27(150-183)	40.69(15-47)	14.63(12-17)	19.63(17-22)	44.74(35-55)
♀ (N=29)	158.48(143-185)	40.41(34-47)	13.50(12-15)	18.31(17-20)	38.10(31-59)
Microtus montanus					
♂ (N=17)	148.31(99-176)	36.81(24-46)	13.56(10-16)	18.94(16-21)	34.58(31-54)
♀ (N=20)	152.11(144-164)	39.00(30-47)	13.16(12-15)	18.55(17-20)	34.58(26-51)
Microtus longicaudus					
♂ (N= 3)	184.30(169-199)	63.00(57-67)	16.00(15-18)	19.00(18-20)	34.00(30-39)
♀ (N= 1)	185.00 (0)	67.00 (0)	15.00 (0)	21.00 (0)	34.00 (0)
Clethrionomys gapperi					
♂ (N= 7)	142.29(133-155)	40.29(33-43)	15.14(12-17)	17.14(16-18)	20.40(20-21)
♀ (N= 3)	147.00(145-149)	40.50(38-43)	15.00(15-—)	18.50(18-19)	23.30(19-28)

when species numbers are much lower than expected, the species may be adversely affecting one another (Whitaker, 1967) as is suggested by this study.

M. montanus occupied a wide range of plant communities and seems capable of existing in large numbers in all of them (with one exception) regardless of the other species present. Competitive interactions seem to be occurring with *M. pennsylvanicus*, resulting in the restriction or total elimination of *M. pennsylvanicus* from certain situations. Murie (1969) and Hodgson (1972) showed that *M. pennsylvanicus* demonstrated a wet substrate preference while *M. montanus* did not. In my study, *M. pennsylvanicus* occurred in largest numbers in the wettest situations and was present in limited numbers or totally absent from areas tending to the drier end of the spectrum. This concurs with Findley (1951, 1954) who concluded: (1) that where the range of *M. pennsylvanicus* overlaps that of *M. montanus*, a species well adapted to dry mountain grasslands, *M. pennsylvanicus* is forced to retire to its optimum niche, the hydrosere community, and (2) that the distribution of *M. pennsylvanicus*, in part at least, is due to competition with closely related microtines.

The relationships of *M. longicaudus* and *C. gapperi* are less clear; *M. longicaudus* is the most restricted of the four microtines. It is apparently capable of coexisting with the other three species, being found in the wetter, more structurally complex plant communities. A similar tendency was exhibited by *C. gapperi*, but it is capable of occupying a slightly wider latitude of situations. Voles of the genera *Clethrionomys* and *Microtus* tend to occupy different habitats, the former woodlands and the latter grasslands (Hall and Kelson, 1959; Southern, 1964). Evidence that *M. pennsylvanicus* and *C. gapperi* tend to inhibit each other from using the opposite species habitat is abundant (Grant, 1969; Morris, 1969; Iverson and Turner, 1972).

Results of my stomach analyses suggest a similarity in food uses, but microtine populations seldom critically deplete their food supplies (Negus and Pinter, 1966). The quality, rather than the quantity, of available food was shown to exert considerable influence on initiation, duration, and success of the breeding season in natural populations of *M. montanus* (Negus and Pinter, 1966). A comparative reproductive investigation showed litter sizes among the four microtines to be similar, with no species having a disadvantage in this respect, except possibly *C. gapperi*, which showed about one-half the pregnancy rate of the other three microtines. This low numerical productivity may be offset by a greater survivorship, or the population may suffer suppression by the superior numbers produced by the other three species. However, the latter probably was not the case, as suggested by the wider latitude of occupancy of plant communities than *M. longicaudus*, which showed greater productivity.

Even though litter sizes are comparable, the first species coming into breeding in the spring would have an advantage, especially if

the females establish a breeding territory excluding all other species as suggested by Stoecker (1970). Over the three months of this study, nearly the entire adult populations of all four microtines were in breeding condition.

Other factors that may be involved in segregation are behavioral interactions (Murie, 1963; Stoecker, 1970) and possible physiological differences in water balance (Getz, 1963). Stoecker (1970), in an analysis of sympatry in *M. pennsylvanicus* and *M. montanus*, found that because of co-occurrence in the same situations and because of the similarity in their time of activity, behavioral contacts unquestionably occur. He found *M. montanus* to agonistically dominate *M. pennsylvanicus*. Social intolerance between the two species was further suggested by the low recruitment of young and by immigration of one species when the other was removed by trapping. Stoecker's (1970) results contrast with those of Grant (1970a), who noted that the outcome of interspecies encounters depends on where and when they occur and upon the relative body sizes of the interactants (larger species almost always wins).

The existence of trends in differential habitat use was clearly demonstrated in this study, and evidence suggests that the four microtines are at least partially incompatible. However, a multiplicity of ecological and behavioral factors are probably operating synergistically to produce the observed species distributions.

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NOTES ON THE OCCURRENCE AND DISTRIBUTION OF *PTERONARCYS CALIFORNICA* NEWPORT (PLECOPTERA) WITHIN STREAMS

John A. Elder[1] and Arden R. Gaufin[1]

Abstract.— During a physiological study that required the collection of several thousand stoneflies, *Pteronarcys californica*, observations were made on the distribution of these aquatic insects within streams. It was noted that *P. californica* occur primarily in large rivers that have loose, unconsolidated substrates and swift currents. They occur from depths of six inches to several feet. They are exclusively vegetarian, feeding on detritus, algae, and diatoms. *P. californica* congregate in dense clumps, but within the clumps they segregate by size. The largest specimens are found in the quietest water. There is evidence of some seasonal variation in their behavior.

Pteronarcys californica is a large stonefly (Order Plecoptera) of the mountain and Pacific west. Because of its large size (often in excess of one gram) and its hardiness compared to other stoneflies, it is an ideal organism to use in physiological studies.

During one such study, observations were made on the occurrence and distribution of this species within river systems. The study required several thousand of these large insects, and collections were made throughout the year. Most of the observations were made in Utah in the lower Provo River below Deer Creek Reservoir. The section containing *Pteronarcys californica* was entirely within Utah County from the immediate vicinity of Vivian Park to the mouth of Provo Canyon. Residents in the area reported that *Pteronarcys californica* had at one time existed close to Deer Creek Reservoir but had been replaced by the smaller *Pteronarcella badia* in recent years. Upon investigation of the tailwater at this point, it was discovered that the fauna and flora had the appearance of a stressed environment. The algae were long, filamentous greens, and the most common invertebrate was an amphipod (many times more common than any other organism). This led us to the conclusion that there was at least one period during the year when poorly oxygenated water was discharged from Deer Creek Reservoir. Apparently *Pteronarcella* can outcompete *Pteronarcys* in this type of stress.

Other rivers where we collected *Pteronarcys californica*, to a limited extent, were the Bear River upstream from Evanston, Wyoming, Uintah County, to near the Utah border; North Fork, Teton River, Idaho, at Idaho 32 bridge, Teton County; and Henry's Fork, Idaho, near the U.S. 20, 191 bridge near Ashton in Fremont County.

Claassen (1931) states that *Pteronarcys* universally inhabits "small, cold, upland spring brooks." This is not true of *Pteronarcys californica*. It inhabits the larger rivers of the west that have large volumes of water throughout the year. Man's alteration of the habi-

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tat can adversely affect its distribution. *Pteronarcys californica* once was numerous on the Gunnison River, Colorado (Knight, 1965), prior to the construction of several dams. In 1972 when we visited the river, *Pteronarcys californica* had not only disappeared below the reservoirs but was very rare above them. Why this has occurred is not known.

Usually *Pteronarcys californica* occurs in dense clumps in larger streams. Occasionally, a few scattered individuals can be found, but stream drift is probably responsible for this. They do not seem to exhibit any drifting behavioral patterns, but in our holding tanks *Pteronarcys californica* were nocturnally active. Heaton (1966) found a 22:1 night-day drift ratio for this species. It is possible that *Pteronarcys californica* drift at night. Their typical behavior when dropped into flowing water or when dislodged from the substrate is to "ball up" and drop to the bottom.

Large populations of *Pteronarcys californica* are typically found in swift water but rarely in "white" water. We have found them in depths ranging from six inches to three feet, and they probably occur deeper. The rocks are notably free of large clumps of algae, and the bottom of rooted aquatics. Loose, unconsolidated bottoms seem to be preferred, with the minimum size of stones approximately six inches and maximum size unknown. In Henry's Fork we collected in excess of 100 individuals from one rock of approximately three feet in diameter.

Pteronarcys californica seem to prefer loose rock where terrestrially derived detritus collects, or rocks with a coating of diatoms and other small green algae. Richardson (1965) reported that *Pteronarcys californica* is a detritus feeder. Our analysis of gut contents from more than 1000 individuals has not revealed a single case of carnivorous feeding.

Pteronarcys californica nymphs tend to segregate by size (size is determined by age and sex). The aquatic stage of this species lasts three years. In a single stretch of water on the Provo River at Vivian Park, third-year females, the largest size, were found farthest upstream in the calmer water with the largest rubble. *Pteronarcys californica* density was the lowest in this type habitat. Downstream, as the depth decreased, the rubble became smaller and looser, and the organisms became smaller and more numerous. Here, while measurements were not made, it appeared that second-year females were mixed with second- and third-year males. First-year specimens were found commonly with the second-year females and second- and third-year males but were most common in areas lacking the larger classes. In the coldest winter months, when the rivers were lowest, there was some indication that the size segregation partially broke down. This was probably due to lack of available habitat.

During the spring, May-July, when *Pteronarcys californica* emerge, the rivers rise to such an extent that sampling is virtually impossible. However, it has been noted by Gaufin that the emerging insects migrate to shallow water, where the rocks are partially ex-

posed. Here they congregate and wait for the cue to emerge. Emergence is accomplished by crawling out of the water onto a rock or shore, splitting the nymphal exoskeleton, and emerging as an adult.

On most rivers where we collected, *Pteronarcys californica*, when found, was extremely abundant, but in very limited areas of one hundred meters or less. On the Henry's Fork, *Pteronarcys californica* was much more abundant than elsewhere we collected. Nevertheless, in any given riffle, a sample of approximately one meter square might yield more than 100 organisms, while only a few meters away on rubble that was superficially identical an area of similar size might yield few, if any, individuals.

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PREHISTORIC BIGHORN SHEEP IN THE NORTHERN SIERRA NEVADA, CALIFORNIA

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Abstract.— Data from pictograph and archaeological sites in northeastern California are used to verify the postulated former existence of small resident populations of bighorn sheep (*Ovis canadensis*) in this region. The reason for the disappearance of bighorns from this area remains unclear, with climatic change, Euro-American settlement, or hunting pressure existing as possibilities.

The known historic range of bighorn (*Ovis canadensis*) in California has been reported by Jones (1950). In the 160 miles between Observation Peak in east central Lassen County and the southeastern portion of Alpine County to the south, there is no record of bighorn sheep except for an isolated sighting east of Donner Pass, Nevada County (Wistar, 1914:113). Some authors (Cowan, 1940; Hall and Kelson, 1959; Buechner, 1960) have posited the entire Sierra Nevada as pristine bighorn range, but no evidence exists in the zoological literature to support this suggestion. Archaeological research in this area during the last decade and a half sheds considerable light on the matter. This note will present a brief review of relevant findings and a description of new material analyzed by the authors.

Three archaeological sites in northeastern California contain rock carvings of bighorns (Heizer and Baumhoff, 1962; Payen, 1966). These are: site 4-Las-38 in Ball's Canyon, 8 miles north of Standish, Lassen County; site 4-Sie-1, ¼ mile southeast of Hawley Lake, Sierra County; and site 4-Pla-26, 11 miles south of Old Highway 40 at Soda Springs, Placer County. Heizer and Baumhoff (1962) and Grant *et al.* (1968) discuss the relevance of pictograph distributions to the prehistoric range of mountain sheep, particularly in Nevada and southeastern California. Their research suggests that these pictographs functioned in hunting rituals. The paucity of such sites in our area of concern, however, lends little aid to range determination.

Direct evidence of late prehistoric sheep populations exists in the faunal remains from five archaeological sites (Figure 1). Age estimations for all the sites are based on artifact typology and are considered reliable, since these are correlated with radiocarbon-dated deposits in neighboring areas of California and Nevada.

Bare Cave (4-Las-S228) is located in northeastern Lassen County at the southernmost end of Surprise Valley, 10.5 miles southeast of Eagleville. Although the fauna from this site has not yet undergone systematic analysis, the authors have identified remains of several individuals of *Ovis canadensis* represented by abundant cranial and postcranial elements. Stratigraphic records on the faunal remains appear to have been lost, and thus changes in sheep abun-

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Fig. 1. Map of the counties of northeastern California showing archaeological sites with bighorn sheep remains (circles) and bighorn pictographs (triangles). Stippling indicates historic range (after Jones, 1950).

dance through time cannot be demonstrated. Brown (1964) dates the deposit between 2000 B.C. and A.D. 1200.

The Karlo site (4-Las-7) is approximately 20 miles northeast of Susanville, Lassen County, near the Karlo siding on the Southern Pacific line between Susanville and Alturas. Riddell (1960) describes numerous bone tools made from metapodials and scapulae of *Ovis canadensis*. Unmodified bones of this species were also present in the deposit. Sheep remains are more abundant in the upper levels of the site, but this correlates with other bone remains and cannot be used as evidence of faunal change. It is suggested that the site was occupied seasonally from ca. 2000 B.C. until the nineteenth century A.D.

Tommy Tucker Cave (4-Las-1) lies 4 miles southeast of Wendel, Lassen County, on the south slope of Hot Springs Peak. Riddell (1956) reports 11 bones assignable to *Ovis canadensis*. Remains from the deposit range in age from ca. A.D. 1000 to the historic period.

Chilcoot Rockshelter (4-Plu-44) is situated 7.5 miles north of Vinton, Plumas County. Bone preservation was extremely poor, and Payen and Boloyan (1961) report only a single specimen attributable to bighorn. The deposit is dated from A.D. 1400 to 1850.

The Loyalton Rockshelter (4-Sie-S43) is located on Elephant Head Peak, 2 miles northeast of Loyalton, Sierra County. Faunal remains were fairly abundant, although the deposit was less than

a foot deep. We recorded 7 adult calvaria definitely assignable to *Ovis canadensis* and 2 foetal crania assignable to *Ovis* and almost certainly associable with the bighorn remains. Postcranial elements were also abundant in the deposit but were so badly smashed for marrow extraction and tool use that few were identifiable. The presence of adults and foetuses indicates occupation of the area by a resident sheep population rather than by stray individuals. Wilson (1963) attributes the deposit to the period between ca. A. D. 1000 and the Euro-American immigration.

The presence of bighorn remains at these sites provides significant indication that the species was widely present in the northern Sierra Nevada of California during the late prehistoric period. The reason for the disappearance of the form over all of this range is unclear. At present, factors such as late climatic change in the area, withdrawal of sheep before immigrating Euro-Americans, or extinction of local populations by hunting are possibilities. Since most of the sites contain very few individuals and only three sheep pictographs have been recorded for the entire area (as opposed to more than 7,000 in Inyo County alone), it is fairly certain that bighorns were never as abundant in this region as they were farther south and east. Thomas (1972) notes that if local bighorn bands are hunted out, their area will be slowly or never repopulated. This results from the maintenance of similar home ranges by bighorn bands from generation to generation. This trait, coupled with low population density, would have facilitated extinction through any of the agencies mentioned above.

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ARTEMISIA ARBUSCULA, *A. LONGILOBA*, AND *A. NOVA* HABITAT TYPES IN NORTHERN NEVADA

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Abstract.— *Artemisia arbuscula*, *A. longiloba*, and *A. nova* are dwarf sagebrush species that occur extensively throughout the shrub steppe of northern Nevada. These species are similar ecologically in that they occupy habitats strongly influenced by edaphic factors. Nine major habitat types on which these shrubs are dominant are recognized in this region. The *A. arbuscula* habitat types are most prevalent in extreme northern Nevada. Southward, they generally become restricted to altitudes above the *Pinus-Juniperus* woodland zone. A single *A. longiloba* habitat type is described, occurring in northeastern Nevada. The *A. nova* habitat types are most prevalent in north central and east central Nevada. Four features appear consistently among soils of these habitat types: (1) shallowness, (2) high profile gravel volume, (3) presence of a clay B horizon close to the soil surface, and (4) presence of large quantities of mineral carbonates throughout profiles of most *A. nova* habitat types.

Artemisia arbuscula, *A. longiloba*, and *A. nova* are dwarf sagebrush species which dominate approximately one-half of the sagebrush vegetation in Nevada (Beetle, 1960). The most extensive communities of these species in Nevada occur in the northern portions of the state and form very distinct and important components of the shrub steppe of this region. Excessive livestock grazing in past years has greatly altered the herbaceous composition of the vegetation of many of these communities. Virtually no synecological studies of undisturbed *A. arbuscula*, *A. longiloba*, and *A. nova* vegetation have been undertaken in Nevada (Passey and Hugie, 1962). Such information would be useful in ascertaining the biotic potential and limitations of the habitats occupied by these shrubs and would greatly aid in the management and manipulation of these communities for grazing and watershed purposes. The purpose of this study was to delimit the characteristics of the major *A. arbuscula*, *A. longiloba*, and *A. nova* habitat types in the shrub steppe of northern Nevada.

Study Area

The study encompassed areas throughout northern Nevada where these species of sagebrush were abundant and where undisturbed vegetation would likely be found. The region referred to as northern Nevada is that portion of the state generally north of the 39th parallel. The physiography of much of this region consists of numerous, short mountain ranges and intermontane basins with internal drainage. Extreme northern Nevada consists of an upwarped plateau of hilly and mountainous terrain with major drainage into the Snake River to the north in Oregon and Idaho. Soils of this region belong predominantly to the Aridisol, Entisol, Mollisol, and Vertisol orders. The climate is arid. The mean annual temperature is 8.9 C, with the coldest temperatures occurring in December through February

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(mean=2.2 C) and the warmest in July and August (mean=20.8 C). The mean total annual precipitation is 239.2 mm. The long-range normals (in mm) for total monthly precipitation are as follows: January 29.2, February 26.4, March 23.9, April 22.9, May 24.6, June 18.0, July 9.9, August 7.6, September 9.9, October 18.8, November 20.6, December 27.4.

The shrub steppe in extreme northern Nevada appears as a uniform, continuous shrub cover occasionally interrupted by *Juniperus* or *Cercocarpus* woodlands. In north central Nevada, shrub steppe communities occupy basins and lower pediment slopes of the mountain ranges. At higher altitudes, the shrub steppe is interrupted by a zone of *Pinus monophylla* and *Juniperus osteosperma* woodlands (Billings, 1951). Above this zone, shrub communities again appear, particularly those dominated by *Artemisia*.

Methods

A preliminary reconnaissance of the vegetation dominated by *Artemisia arbuscula*, *A. longiloba*, and *A. nova* gave an indication of the community types, distribution, and pattern of occurrence. Lists of the dominant species within each stand were taken during the reconnaissance. These species were then ranked according to their abundance. Nine community types were subjectively delineated by examination of these lists in stand tables. Based on this initial classification, 39 stands representing the various community types were selected for detailed study on the basis of the following criteria: absence of disturbance due to grazing, erosion, and wildfire; absence of a tree overstory; presence of a uniform shrub and grass cover.

Vegetation data were collected from a 15-by-30-m macroplot located within each of the 39 stands. Ten 15-m transects were randomly located perpendicular to the long axis of the macroplot. Frequency data for plant species were collected from 10 3-by-6-dm observation plots placed at 1-m intervals along each transect. Only species rooted within each observation plot were tallied. The same observation plots were used to sample basal area of each species along 4 of the 10 transects. Species not recorded in the observation plots but present within the macroplot were listed. Shrub measurements were collected from 1-by-1-m plots placed contiguous and parallel to the same 4 transects from which basal area data were collected. Crown cover, density, and maximum heights were recorded for each shrub species within each meter-square plot.

Physiographic features recorded at each location were: percentage slope, slope aspect, position of the stand on the slope, elevation, landform on which the stand occurred, and terrain of the general area in which the stand occurred. A profile description of the soil underlying each stand was made and identified to the family level (Soil Survey Staff, 1967). One soil sample from each horizon of each profile was collected for laboratory analysis. Soil reaction was measured on a saturated paste with a glass electrode pH meter. Electrical conductivity of an extract from a saturated paste was determined only on

the A1 and B2 horizons of each profile. Calcium carbonate equivalents were determined by gravimetric loss of carbon dioxide upon treatment with 3NHCl for all horizons.

The vegetation data from the 39 stands were summarized in stand tables and mean values for the various characteristics calculated. The vegetation and associated environmental characteristics were interpreted according to the association and habitat type synecological concepts (Daubenmire, 1968). Stands similar in both shrub and herb dominance were considered representative of an association. A habitat type is a unit of land that now supports or is still capable of supporting one plant association. The name of each habitat type consists of the name of the principal shrub and herb of the association which occupies it. Species nomenclature follows that of Ward (1953) and Beetle (1960) for *Artemisia* and Holmgren and Reveal (1966) for other vascular plants.

Description of Habitat Types

Artemisia arbuscula is most abundant throughout extreme northern Nevada. Southward into central Nevada, *A. arbuscula* is found predominantly at higher altitudes above the *Pinus monophylla-Juniperus osteosperma* woodland zone. *A. longiloba* occurs almost entirely within a small area in north central Elko County in northeastern Nevada. Occasional small, insular stands may be found in surrounding counties. *A. nova* is most abundant in the north central and eastern portions of the state. Scattered, insular stands may be found throughout northern and southern Nevada.

The physiognomy of the vegetation is quite similar throughout the entire range of these species in Nevada. The shrubs appear as a low, uniformly distributed population interspersed by perennial, caespitose grasses. Separate shrub and grass layers are not always distinguishable because of the similarity in height of most shrubs and grasses. In most areas, individual stands of these dwarf sagebrush species are contiguous to extensive communities of *A. tridentata*, the predominant sagebrush species in Nevada. Ecotones between contiguous stands often appear abrupt. The low, compact growth form of *A. arbuscula*, *A. longiloba*, and *A. nova* contrast sharply with the taller, robust, and diffusely branched growth form of *A. tridentata*.

Nine major habitat types were recognized on the basis of shrub and grass dominance in this region. The 39 stands studied in detail represent the vegetation of 8 of the habitat types. An additional habitat type is described on the basis of reconnaissance data only. Constancy, basal area, and frequency of major plant species in each association are given in Tables 1 and 3. Shrub characteristics are shown in Tables 2 and 4.

(1) *Artemisia arbuscula-Festuca idahoensis* habitat type

This habitat type is found on slopes and ridgetops of hilly and mountainous terrain throughout much of northern Nevada at alti-

TABLE 1. Mean values for vegetation characteristics[a] of the *Artemisia arbuscula* and *A. longiloba* associations.

Species	*A. arbuscula–Festuca idahoensis* n=5[b]			*A. longiloba–Festuca idahoensis* n=2			*A. arbuscula–Stipa thurberiana* n=4			*A. arbuscula–Agropyron spicatum* n=9			*A. arbuscula–Purshia tridentata–Agropyron spicatum* n=3		
	CN	FR	CV	CN	FR	CV	CN	FR	CV	CN	FR	CV	CN	FR	CV
SHRUBS															
Artemisia arbuscula	100	55	0.8	—	—	—	100	45	1.0	100	64	1.4	100	51	1.7
Artemisia longiloba	—	—	—	100	58	1.4	—	—	—	—	—	—	—	—	—
Chrysothamnus viscidiflorus	100	11	0.1	50	5	T	100	10	0.1	89	14	0.1	100	3	T
Eriogonum heracleoides	60	9	T	50	4	0.1	—	—	—	11	—	—	67	4	T
Eriogonum microthecum	60	3	T	—	—	—	100	5	T	56	11	T	67	17	T
Leptodactylon pungens	40	1	T	50	11	T	75	5	T	40	4	T	—	—	—
Tetradymia canescens	—	—	—	—	—	—	—	—	—	33	T	—	100	1	T
Symphoricarpos longiflorus	—	—	—	—	—	—	—	—	—	22	T	T	67	4	T
Artemisia tridentata	—	—	—	—	—	—	—	—	—	11	T	T	100	2	T
Purshia tridentata	—	—	—	—	—	—	—	—	—	11	—	—	100	31	1.0
GRASSES															
Festuca idahoensis	100	68	2.1	100	80	2.7	50	8	0.1	—	—	—	—	—	—
Poa sandbergii	100	76	1.2	100	74	1.2	100	72	0.5	100	84	1.4	100	23	0.1
Agropyron spicatum	100	33	0.4	100	35	0.7	100	2	T	100	68	1.6	100	71	0.6
Sitanion hystrix	100	11	T	100	27	0.3	100	37	0.3	89	11	T	100	2	T
Koelaria cristata	40	2	T	—	—	—	75	4	T	—	—	—	—	—	—
Stipa thurberiana	40	4	T	—	—	—	100	59	1.1	33	6	T	—	—	—
Bromus tectorum	20	T	—	—	—	—	75	14	T	67	4	T	67	17	T
Poa nevadensis	—	—	—	—	—	—	—	—	—	—	—	—	67	9	T
Stipa lettermani	—	—	—	—	—	—	—	—	—	—	—	—	67	2	T
FORBS															
Collinsia parviflora	100	61	T	100	11	T	100	84	0.1	67	41	T	100	66	T
Antennaria dimorpha	100	3	T	—	—	—	100	7	T	44	2	T	—	—	—
Erigeron bloomeri	100	4	T	—	—	—	100	14	T	—	—	—	—	—	—
Agoseris glauca	80	26	T	100	29	T	100	10	T	56	7	T	—	—	—
Crepis accuminata	80	7	T	—	—	—	50	2	T	56	1	T	100	3	T
Balsamorhiza sagittata	80	—	—	—	—	—	25	1	T	22	—	—	100	8	T

TABLE 1 (Continued)

Allium acuminatum	80	19	T	50	5	T	10	5	T	—	—	—	—	—	—
Phlox longifolia	80	35	T	100	50	T	100	34	T	89	48	T	100	45	T
Arabis holboellii	80	9	T	50	11	T	75	T	—	89	10	T	100	7	T
Astragalus purshii	80	5	T	—	—	—	100	2	T	67	3	T	100	3	T
Senecio integerrimus	60	20	T	100	30	T	25	1	—	11	T	T	33	6	T
Polygonum spergulariaeforme	60	11	T	100	46	T	—	—	—	33	2	T	100	19	T
Chaenactis douglasii	60	1	T	—	—	—	25	—	—	—	—	—	—	—	—
Gayophytum ramosissimum	60	18	T	—	—	—	—	—	—	56	11	T	33	T	T
Mertensia oblongifolia	60	9	T	—	—	—	—	—	—	—	—	—	—	—	—
Microsteris gracilis	60	23	T	—	—	—	75	24	T	22	15	T	—	—	—
Trifolium gymnocarpon	60	10	T	50	5	T	50	3	T	—	—	—	—	—	—
Cryptantha spp.	40	T	T	100	10	T	25	4	T	67	12	T	67	2	T
Aster scopulorum	40	10	T	—	—	—	100	21	0.4	67	5	T	67	6	0.1
Astragalus miser	40	7	T	—	—	—	100	5	T	22	5	T	—	—	—
Cordylanthus ramosus	40	9	T	100	14	T	—	—	—	11	3	T	—	—	—
Delphinium andersoni	40	4	T	—	—	—	100	5	T	11	T	T	67	1	T
Haplopappus carthamoides	40	7	T	100	5	—	—	—	—	—	—	—	—	—	—
Lomatium dissectum	40	11	T	—	—	—	100	13	T	—	—	—	—	—	—
Phlox hoodii	40	5	0.1	—	—	—	100	10	0.2	—	—	—	—	—	—
Descurainia pinnata	20	T	—	50	2	T	100	21	T	11	6	T	33	3	T
Eriastrum sparsiflorum	20	11	T	—	—	—	75	28	T	22	7	T	—	—	—
Eriogonum ovalifolium	20	1	T	50	9	0.2	75	4	T	—	—	—	—	—	—
Castilleja chromosa	—	—	—	50	8	T	—	—	—	56	4	T	100	1	T
Calochortus nuttallii	—	—	—	—	—	—	—	—	—	44	T	T	100	3	T
Chenopodium leptophyllum	—	—	—	—	—	—	—	—	—	33	T	T	100	3	T
Crepis modocensis	—	—	—	—	—	—	—	—	—	33	T	T	67	11	T
Haplopappus acaulis	—	—	—	—	—	—	—	—	—	33	6	0.1	100	7	0.2
Penstemon watsonii	—	—	—	—	—	—	—	—	—	22	1	T	67	14	T
Senecio millelobatus	—	—	—	—	—	—	—	—	—	11	T	T	66	T	T
Erigeron eatonii	—	—	—	—	—	—	—	—	—	—	—	—	67	7	T

[a]Only species which attain a constancy of 60 percent or greater in one association are shown;
CN = constancy (percentage of occurrence of a species in stands of a given association);
FR = percentage of 100 3-by-6-dm plots in which a given species occurs;
CV = basal area (percentage basal coverage within a 3-by-6-dm plot);
T = trace (frequency less than 1 percent; basal area less than 0.1 percent).
[b]n = number of stands studied in detail.

TABLE 2. Mean values for shrub characteristics[a] of the *Artemisia arbuscula* and *A. longiloba* associations.

	A. arbuscula–Festuca idahoensis			*A. longiloba–Festuca idahoensis*			*A. arbuscula–Stipa thurberiana*			*A. arbuscula–Agropyron spicatum*			*A. arbuscula–Purshia tridentata–Agropyron spicatum*		
	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv
Artemisia arbuscula	219	18	12	—	—	—	126	19	12	266	11	12	168	17	16
Artemisia longiloba	—	—	—	200	24	19	—	—	—	—	—	—	—	—	—
Chrysothamnus viscidiflorus	28	17	1	5	18	T	29	19	T	35	12	1	6	32	T
Eriogonum microthecum	5	11	T	1	15	T	6	16	T	28	13	T	30	22	1
Artemisia tridentata	T	46	T	T	60	T	T	20	T	T	26	T	4	33	T
Leptodactylon pungens	2	20	T	16	21	T	18	17	T	7	16	T	—	—	—
Tetradymia canescens	3	27	T	—	—	—	—	—	—	T	15	T	2	31	1
Eriogonum heracleoides	16	12	T	—	—	—	—	—	—	—	—	—	—	—	—
Purshia tridentata	—	—	—	—	—	—	—	—	—	T	13	T	56	47	19
Symphoricarpos longiflorus	—	—	—	—	—	—	—	—	—	—	—	—	5	32	2

[a]No = density (number of plants per 60 m^2); Ht = maximum height in cm; Cv = crown cover of a m^2 plot; T = trace (crown cover value less than 1 percent; density less than 1 plant per 60 m^2).

TABLE 3. Mean values for vegetation characteristics[a] of three *Artemisia nova* associations.

Species	*A. nova–Agropyron spicatum* n=6[b]			*A. nova–Agropyron inerme* n=5			*A. nova–Stipa comata* n=5		
	Cn	Fr	Cv	Cn	Fr	Cv	Cn	Fr	Cv
TREES									
Juniperus osteosperma	66	T	—	—	—	—	20	—	—
Pinus monophylla	33	T	—	—	—	—	60	T	—
SHRUBS									
Artemisia nova	100	56	1.2	100	57	1.2	100	56	1.5
Chrysothamnus viscidiflorus	83	8	T	100	4	T	100	5	0.1
Eurotia lanata	17	2	T	20	T	—	80	7	T
Ephreda viridis	—	—	—	—	—	—	60	1	T
GRASSES									
Agropyron spicatum	100	79	1.4	—	—	—	—	—	—
Poa sandbergii	100	37	0.3	100	42	0.2	100	5	T
Sitanion hystrix	17	4	T	80	6	T	100	6	T
Agropyron inerme	—	—	—	100	58	1.4	—	—	—
Stipa comata	—	—	—	—	—	—	100	50	0.5
FORBS									
Calochortus nuttallii	100	6	T	20	T	T	100	4	T
Phlox longifolia	100	36	T	60	6	T	80	10	T
Arabis holboellii	83	8	T	100	9	T	80	2	T
Haplopappus acaulis	83	17	0.4	60	1	T	—	—	—
Astragalus purshii	67	3	T	60	1	—	100	3	T
Cryptantha humilis	67	12	T	—	—	—	—	—	—

Table 3 (Continued).

Streptanthus cordatus	67	T	T	—	—	—	20	T	T
Agoseris glauca	50	3	T	60	4	T	—	—	—
Astragalus beckwithii	50	T	T	80	4	T	—	—	—
Delphinium andersoni	33	2	T	60	2	T	—	—	—
Eriogonum ovalifolium	33	1	T	40	T	—	60	1	T
Gilia clokeyi	33	23	T	40	6	T	100	9	T
Lomatium macdougali	33	T	T	100	11	T	—	—	—
Cryptantha spp.	17	T	T	60	1	T	60	2	T
Linum lewisii	17	T	T	—	—	—	60	T	T
Erigeron pumilis	—	—	—	100	1	T	80	2	T
Descurainia pinnata	—	—	—	60	3	T	60	2	T

[a]Only species which attain a constancy of 60 percent or greater in one association are shown;
Cn = constancy (percentage of occurrence of a species in stands of a given association);
Fr = percentage of 100 3-by-6-dm plots in which a given species occurs;
Cv = basal area (percentage basal coverage within a 3-by-6-dm plot);
T = trace (frequency less than 1 percent; basal area less than 0.1 percent)
[b]n = number of stands studied in detail.

TABLE 4. Mean values for shrub characteristics[a] of three *Artemisia nova* associations.

	A. nova–Agropyron spicatum			*A. nova–Agropyron inerme*			*A. nova–Stipa*		
	No	Ht	Cv	No	Ht	Cv	No	Ht	Cv
Artemisia nova	181	23	13	133	14	11	216	15	12
Chrysothamnus viscidiflorus	17	20	1	7	15	T	18	13	T
Eurotia lanata	7	6	T	T	9	T	15	14	T
Ephreda viridis	T	30	T	T	11	T	1	49	T
Eriogonum microthecum	4	12	T	—	—	—	—	—	—
Tetradymia canescens	2	22	T	—	—	—	—	—	—
Leptodactylon pungens	2	27	T	—	—	—	—	—	—
Grayia spinosa	—	—	—	T	19	T	—	—	—
Atriplex confertifolia	—	—	—	2	19	T	2	16	T

tudes ranging from 1900 to 2000 m. *Artemisia arbuscula* is the dominant shrub of the association. *Festuca idahoensis* is the dominant perennial herb, with *Poa sandbergii* and *Agropyron spicatum* the principal subdominants. Low scattered bushes of *Chrysothamnus viscidiflorus* occur in all stands. *Bromus tectorum*, the only annual grass, occurs in very minute amounts but becomes abundant in most seral stands. Forbs in all *Artemisia arbuscula* associations are very low in basal area but often attain relatively high frequencies. Soils supporting stands studied in detail were divided among the subgroups Typic Haploxerolls, Typic Argixerolls, Typic Durixerolls, and Xerollic Camborthids. The association is similar to those described by Eckert (1957), Tueller (1962), Culver (1964), Hall (1967), and Dealy (1971) in central and eastern Oregon.

(2) *Artemisia longiloba-Festuca idahoensis* habitat type

In north central Elko County in northeastern Nevada, stands of *Artemisia longiloba* may be found on slopes of gently rolling to hilly terrain at altitudes ranging from 1900 to 2100 m. Only two stands were found that were not extensively altered by grazing. Except for the substitution of *Artemisia longiloba* for *Artemisia arbuscula*, the vegetation closely resembles that of the *Artemisia abruscula-Festuca idahoensis* association in both floristics and abundance of herbaceous species. Soils of the two stands belong to the subgroups Xerollic Camborthids and Mollic Paleargids. Tisdale, Hironaka, and Fosberg (1965) described a pristine *Artemisia longiloba-Festuca idahoensis-Stipa thurberiana* community in southern Idaho. The abundance of *S. thurberiana* was the only major difference between the community in Idaho and the two stands in Nevada. Hugie, Passey, and Williams (1964) described an *Artemisia longiloba* community in the Snake River Plain, Idaho, in which *F. idahoensis*, *Agropyron spicatum*, and *Poa sandbergii* were the principal grasses. Robertson, Nielsen, and Bare (1966) report that *Agropyron spicatum* is the pre-

dominant grass associated with *Artemisia longiloba* on range site in Colorado.

(3) *Artemisia arbuscula-Stipa thurberiana* habitat type

The *Artemisia arbuscula-Stipa thurberiana* habitat type occurs on gently rolling to hilly terrain primarily in northwestern Nevada at altitudes varying around 1800 m. Stands are distinguished by the dominance of the perennial grass *Stipa thurberiana*. Subdominant grasses include *Poa sandbergii* and *Sitanion hystrix*. *Festuca idahoensis* is low in constancy. Mat-forming forbs are a conspicuous component of the vegetation, the most prevalent species being *Eriogonum ovalifolium*, *Phlox hoodii*, *Aster scopulorum*, and *Astragalus purshii*. Soils underlying stands studied in detail belong to the subgroups Mollic Paleic Durargids, Mollic Paleargids, Mollic Haplargids, and Typic Durixerolls.

(4) *Artemisia arbuscula-Agropyron spicatum* habitat type

The *Artemisia arbuscula-Agropyron spicatum* habitat type occurs on slopes and ridgetops of hilly and mountainous terrain in northeastern and east central Nevada (Figure 1). Altitudes of stands range from 1900 to 2700 m. The association is characterized by the abundance of *Agropyron spicatum*. *Festuca idahoensis* is usually absent but may occur in minute amounts. In some stands, *Poa sand-*

Fig. 1. Stand representative of the *Artemisia arbuscula–Agropyron spicatum* association in northern Nevada. The meter stake is marked in decimeters.

bergii may equal or exceed *Agropyron spicatum* in both basal area and frequency. *Chrysothamnus viscidiflorus* is the only other shrub of high constancy. In east central Nevada, this association was found only above the *Pinus-Juniperus* woodland zone. The growth form of *Artemisia arbuscula* was greatly altered at these higher altitudes, appearing as an almost prostrate shrub with dense, flattened canopies. Scattered bushes of *Artemisia frigida* and *Artemisia nova* may be present in these stands. Soils supporting the stands studied in detail are divided among the subgroups Lithic Argixerolls, Typic Haploxerolls, and Mollic Haplargids. Eckert (1957), Culver (1964), and Hall (1967) described similar associations in central and eastern Oregon.

(5) *Artemisia arbuscula-Purshia tridentata-Agropyron spicatum* habitat type

The *Artemisia arbuscula-Purshia-Agropyron* habitat type was found only on the pediment slopes of Duck Creek Basin in the Schell Creek mountain range northeast of Ely, Nevada (Figure 2). These slopes are dissected, forming many narrow to broadly rounded ridges extending from the mountain range into the basin. Stands occur between 2400 and 2500 m elevation. All soils described belong to the subgroups Typic Argixerolls. Codominance of the shrubs *Artemisia arbuscula* and *Purshia tridentata* characterizes the association. *Pursh-*

Fig. 2. Stand representative of the *Artemisia arbuscula Purshii tridentata-Agropyron spicatum* association in the Duck Creek Basin in east central Nevada.

ia tridentata has a slightly larger crown cover than *Artemisia arbuscula* but considerably lower density (Table 2). Scattered individuals of *Artemisia tridentata*, *Symphoricarpos longiflorus*, *Tetradymia canescens*, and *Chrysothamnus viscidiflorus* occur throughout the vegetation. *Agropyron spicatum* is the dominant perennial herb. Stands of this association occur at the lower edges of the *Pinus monophylla-Juniperus osteosperma* zone within the basin. Dealy (1971) described a *Purshia tridentata-Artemisia arbuscula-Stipa thurberiana* community in south central Oregon which occurred near the lower edge of the *Pinus ponderosa* forests.

(6) *Artemisia nova–Agropyron spicatum* habitat type

The *Artemisia nova–Agropyron spicatum* habitat type occurs throughout north central Nevada, principally on slopes of gently rolling to hilly terrain at altitudes ranging from 2000 to 2300 m (Figure 3). This habitat type may also occur at higher altitudes on certain mountain ranges where soils are derived from calcareous parent materials. Such areas are found in the Snake, Schell Creek, and Egan ranges of east central Nevada. *Artemisia nova* is the principal shrub and *Agropyron spicatum* the principal herb. *Poa sandbergii* occurs in small amounts in most stands but increases in abundance at higher elevations. Other grasses such as *Poa nevadensis*,

Fig. 3. Stand representative of the *Artemisia nova–Agropyron spicatum* association on slopes of the Schell Creek Range in east central Nevada. The meter stake is marked in decimeters.

Bromus tectorum, *Oryzopsis hymenoides*, *Sitanion hystrix*, and *Stipa thurberiana* are present in very limited amounts. *Chrysothamnus viscidiflorus* is the only other shrub of high constancy. Stands of this association and *Artemisia tridentata* communities often constitute the major vegetation directly below and above the *Pinus monophylla–Juniperus osteosperma* woodland zone in east central Nevada. *Artemisia nova* may also occupy openings within the woodlands and form a shrub layer beneath the tree canopies. The soils supporting the stands studied in detail were divided among the subgroups Typic Torriorthents, Pachic Argixerolls, Typic Durixerolls, Pachic Haploxerolls, and Xerollic Paleorthids.

(7) *Artemisia nova–Agropyron inerme* habitat type

This habitat type occurs on foothill slopes of the Pancake mountain range predominantly in Nye County in central Nevada. It ranges in altitude from 1800 to 2100 m. *Agropyron inerme* is the dominant herb. The tall, robust, caespitose growth form of this grass is the most conspicuous feature of the physiognomy. *Poa sandbergii* and *Sitanion hystrix* are the only other grasses with high constancy among the stands. Stands of the *Artemisia nove–Agropyron inerme* association are commonly associated with extensive communities of *Atriplex confertifolia* and *Grayia spinosa*. Influence of the *Atriplex* and *Grayia* vegetation on these stands is evident in the presence of shrubs such as *Atriplex confertifolia*, *Eurotia lanata*, *Ephedra viridis*, and *Grayia spinosa*, which are characteristic of the *Atriplex* and *Grayia* vegetation. The soils described belong to the Aridisol subgroups Mollic Paleargids, Mollic Haplargids, and Lithic Mollic Haplargids.

(8) *Artemisia nova–Stipa comata* habitat type

The *Artemisia nova–Stipa* habitat type is found in White Pine County on pediment slopes of hilly terrain. The altitudinal range is 2000 to 2200 m. The association is characterized by the abundance of *Stipa comata*. *Poa sandbergii* and *Sitanion hystrix* are highly constant grasses but are low in frequency and basal area. *Bromus tectorum* and *Hilaria jamesii* may be present in very small amounts. *A. nova* has a high density in comparison to other *A. nova* associations (Table 2). Scattered individuals of *Chrysothamnus viscidiflorus* and *Eurotia lanata* are generally present. Soils underlying these stands belong to the subgroups Typic Torriorthents and Xerollic Paleorthids.

(9) *Artemisia nova–Oryzopsis hymenoides* habitat type

The *Artemisia nova–Oryzopsis* habitat type is described only from reconnaissance data. The vegetation of this habitat type has been severely grazed by livestock in the past. Because of the nature of the terrain, the vegetation is easily accessible and conducive to fall and winter grazing by livestock. No stands were found that had

not been affected by grazing to various degrees. However, the species composition of the vegetation is quite constant over large areas even though the herbage is often reduced to very small quantities by livestock.

The habitat type occurs extensively on undulating and gently rolling pediment slopes in the intermontane basins in central and east central Nevada (Figure 4). These slopes are generally less than 5 percent in steepness. Areas of the *Artemisia nova–Oryzopsis* habitat type generally occur over an altitudinal range of 1800-2300 m. Soils are predominantly of the Aridisol and Entisol orders.

Artemisia nova is the dominant species of the vegetation. *Chrysothamnus viscidiflorus* and *Eurotia lanata* are the only shrubs commonly occurring with *Artemisia nova*. The following additional shrubs may occur and are listed in order of decreasing presence: *Ephredra viridis*, *Atriplex confertifolia*, *Eriogonum microthecum*, *Artemisia tridentata*, *Leptodactylon pungens* and *Tetradymia canescens*. The herb layer is very sparse, composed principally of the caespitose grass *O. hymenoides*. Other grasses that may be occasionally found are *Poa sandbergii*, *Sitanion hystrix*, *Stipa comata*, and *Hilaria jamesii*. Forb species are generally scarce throughout the vegetation. The most abundant, in order of decreasing presence, are *Phlox hoodii*, *Eriogonum ovalifolium*, *Haplopappus acaulis*, *Caulanthus crassicaulis*, *Erigeron pumilis*, *Phlox longifolia*, *Sphaeralcea*

Fig. 4. Stand representative of the *Artemisia nova–Oryzopsis hymenoides* association in central Nevada.

grossulariaefolia, and *Astragalus calycocus*. Stands of the *Artemisia nova–Oryzopsis* association are commonly contiguous with stands of *Atriplex*, *Eurotia lanata*, and *Grayia spinosa*.

Soils

Considerable variation in morphology was encountered among the soils of the *Artemisia arbuscula*, *Artemisia longiloba* and *Artemisia nova* habitat types. Of the 39 soils described, 25 different families were identified. This was expected, since many of the soils are distributed over a wide geographical area and occur in a variety of topographic positions. The more prominent features of the collective soils are described.

The sola thickness of soils of the *Artemisia arbuscula* and *Artemisia longiloba* habitat types varied from 23 to 87 cm, with an average of 55 cm. Sixty-five percent of these soils have dense clay horizons (B2t). The upper boundaries of these horizons varied from 7 to 36 cm below the soil surface, with an average of 19 cm. These prominent clay horizons did not form a root-restricting layer, since roots were abundant throughout their depth. Sixty-five percent of the soils have sola with high gravel volumes ranging from 20 to 62 percent. The majority of these soils belong to the *Artemisia arbuscula–Agropyron* and *Artemisia arbuscula–Purshia–Agropyron* habitat types. Those soils lacking dense clay horizons have sola with high gravel volumes. Root-restricting layers (duripans or bedrock) were found in only 21 percent of the soils, occurring at depths of 23-87 cm. The remaining soils were generally underlain by gravelly loam strata. The occurrence of these layers was not restricted to soils of any particular habitat type. Sola of the *Artemisia arbuscula* and *Artemisia longiloba* soils were not calcareous nor alkaline. Soil reaction of the A1 and B2 horizons varied from pH 5.5 to 7.4, with electrical conductivities ranging from 0.1 to 1.0 mmhos per cm.

The sola thickness of soils of the *Artemisia nova* habitat types varied from 7 to 89 cm, with an average of only 26 percent of the *Artemisia nova* soils described having dense clay horizons. The upper boundaries of these horizons ranged from 7 to 15 cm below the soil surface. Eighty-one percent of the *Artemisia nova* soils have high volumes of gravel in their sola, varying from 26 to 52 percent. Root-restricting layers (duripans, petrocalcic horizons, or bedrock) were found in 50 percent of the soils at depths of 29-68 cm and did not occur predominantly in any one habitat type. The remaining soils were generally underlain by gravelly and sandy loam strata. The majority of the soils of the *Artemisia nova* habitat types are calcareous throughout their sola. Percentage $CaCO_3$ equivalents of the A1 and B2 horizons varied from 9 to 36 percent. Soil reaction of these horizons ranged from pH 6.6 to 8.5, with electrical conductivities varying from 0.2 to 0.7 mmhos per cm. However, sola of soils of the *Artemisia nova–Agropyron inerme* habitat type are generally free of detectable mineral carbonates. Carbonates are present in C horizons at depths of 23-41cm. Soil reaction of the A1 and B2 hori-

zons in these soils ranged from pH 6.3 to 7.7, with electrical conductivities varying from 0.2 to 1.1 mmhos per cm.

Discussion

Artemisia arbuscula, *A. longiloba*, and *A. nova* vegetation is present in numerous states surrounding Nevada (Ward, 1953; Beetle, 1960). Studies in these areas have generally indicated that the distributions of these species are edaphically determined.

Eckert (1957), Tueller (1962), Culver (1964), Hall (1967), and Dealy (1971) found *A. arbuscula* associations in central and southeastern Oregon to occur on soils that were shallow, stony, and had moderately to strongly structured B2t horizons high in clay and very close to the soil surface. Hugie, Passey, and Williams (1964) and Tisdale, Hironaka, and Fosberg (1965) in southern Idaho and Robertson, Nielsen, and Bare (1966) in Colorado report similar morphology for soils underlying *A. longiloba* communities. Fosberg and Hironaka (1964) compared soils supporting *A. arbuscula* and *A. tridentata* communities in southern Idaho. *A. arbuscula* was restricted to soils that had a clay B horizon or bedrock within 33 cm from the surface or to weakly developed soils that were as deep as 50 cm but had over 30 percent gravels and cobbles distributed throughout their profiles. Soils supporting *A. tridentata* communities were deeper and had weaker profile development. They suggested that the properties of the *A. arbuscula* soils result in conditions of poor aeration in the rooting zone during the winter and spring months due to the development of a perched water table above the dense clay horizon or bedrock. Summerfield (1969) concluded that the depth of a clayey horizon of prominent, compound prismatic, and blocky structure below the soil surface was the only consistent morphological difference between soils supporting *A. arbuscula* and *A. tridentata* communities in northwestern Nevada. These horizons occurred from 7 to 31 cm under *A. arbuscula* communities and 31 to 53 cm under *A. tridentata* communities.

Shantz (1925), Shreve (1942), Fautin (1946), Thatcher (1959), and Richards and Beatley (1965) describe *A. nova* communities occurring on gravelly, shallow soils on ridgetops or slopes. Andre, Mooney, and Wright (1965) observed that in the White Mountains of California *A. nova* was most prevalent on limestone areas. Hironaka (1963) found that *A. nova* occurred on highly calcareous soils and shallow gravelly soils developed from limestone parent material.

Although there is considerable variation in the soils of the habitat types described in this study, four salient features appear consistently among the soils. These features are: (1) shallowness and thinness of the sola, (2) presence of a dense clay B horizon close to the soil surface, (3) a high volume of gravel throughout the profile, and (4) presence of mineral carbonates throughout most sola of the *A. nova* habitat types. The regularity of occurrence of these features is confirmed by the studies of Blackburn et al. (1968, 1969) of the vegetation and associated site characteristics on watersheds through-

out northern Nevada. The presence of a dense clay B horizon was the most commonly occurring feature among the *A. arbuscula* and *A. longiloba* soils. In soils lacking this prominent horizon, very high gravel volumes occurred throughout the profile. Not all of the soils that lacked this dense clay B horizon were shallow, however . Several of the soils contained no restricting layer within a meter of the soil surface, indicating that extreme droughtiness may be the dominant physical factor of these soils. Shallowness, high gravel volumes, and presence of large quantities of mineral carbonates were the most commonly occurring features of the *A. nova* soils.

Acknowledgments

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SIGNIFICANT BIRD RECORDS FROM UTAH

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ABSTRACT.— New or additional records of six species of birds are reported for Utah: Red-throated Loon, Black-legged Kittiwake, Vaux's Swift, Blue Jay, Magnolia Warbler, and Rose-breasted Grosbeak. All are substantiated by museum specimens. Unless reported for the first time, other records for the state for these rare birds are summarized.

Three birds either new or rare in Utah were taken in the spring of 1972 by a field party from the University of Utah to the Beaver Dam Wash in extreme southwestern Utah. In addition, specimens of three birds new to the state have been submitted to the museum in recent years by interested individuals. These six kinds are hereby placed on record in order to update the checklist of the birds of the state.

Red-throated Loon

A loon of this species, *Gavia stellata*, was first seen at the Bear River Migratory Bird Refuge by refuge personnel on 28 July 1973. It remained several days and was observed by many others. Becoming languid, it was eventually captured and taken to headquarters for observation, but it died on 21 August. An autopsy revealed that a catfish spine was lodged in the esophagus and had perforated the wall. By implication, the bird died from starvation. It was emaciated. However, the bird was also host to many endoparasites. It was a male. The specimen was presented to the University of Utah by Lloyd Gunther, refuge manager, and is now a study skin in the collection.

Black-legged Kittiwake

A male of *Rissa tridactyla tridactyla* was picked up dead, although in fresh condition, at the Fish Springs National Wildlife Refuge, 40 miles southwest of Dugway, Juab County, Utah, on 12 March 1972, by a trapper, Jim Harrison, and was relayed to the University by John Venegoni and Lloyd Gunther, refuge managers. The specimen weighed 265 g and the testes measured 6 x 2 mm. This is the only record of the species for Utah; hence, it is of accidental status.

Vaux's Swift

A female of *Chaetura vauxi vauxi* was taken at the Terry Ranch in the Beaver Dam Wash, 2500 ft elevation, five miles north of the Utah-Arizona border, Washington County, Utah, on 19 May 1972, by William Buntin, M.D. It was a lone bird. The ova measured 0.5 mm in diameter. This is the first unquestionable specimen of record for the state. Woodbury et al. (1949:18) note the existence of a

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mummified skin found on 28 October 1939 in a stove in a cabin at the New State Gun Club or Jordan Fur Farm, Davis County, near the mouth of the Jordan River. The bird had presumably been trapped there sometime during the late spring or summer of 1939.

In addition to these two specimens there are several sight records for the species. Two were seen in a flock of other kinds of swifts and swallows on 10 May 1959 at Provona Beach, Utah Lake, near the mouth of the Provo River (National Audubon Society, 1959:391). One was seen at Utah Lake on 12 May 1963 (National Audubon Society, 1963b:422). Three were seen at the Gap, near Parowan, on 31 August 1964 (National Audubon Society, 1965:64), and three were seen at Springdale near the mouth of Zion Canyon from 11 to 15 September 1965 (National Audubon Society, 1966:77). Thus it appears that the species is a regular but uncommon transient through the state in both spring and autumn.

Blue Jay

The first specimen of *Cyanocitta cristata cyanotephra* from the state, a female, was taken by John Bushman at Holladay, Salt Lake County, Utah, 4500 ft elevation, on 30 April 1970. A jay of this species, possibly the same individual, had been observed in scrub oaks in the same area off and on since 5 January 1969. Another example was observed in the area during the winter of 1970-71. There are some earlier sight records for Utah, one by Dr. and Mrs. Carl L. Hubbs (*in litt.*) on 25 June 1950 on the Markagunt Plateau, Iron County, beside State Highway 143 near its junction with the road leading to the summit of an eminence known as Brian Head. The location was in coniferous forest immediately north of the northern boundary of Cedar Breaks National Monument at an elevation of about 10,000 ft. Another sighting in the same general vicinity was made by the late Stuart Murie (National Audubon Society, 1967:63) on 29 October 1966 at a locality that he simply designated as Cedar Mountain east of Cedar City.

Magnolia Warbler

A male of *Dendroica magnolia* was taken by the writer in a low desert shrub at the Terry Ranch, 2500 ft elevation, Beaver Dam Wash, five miles north of the Utah-Arizona border, Washington County, Utah, on 19 May 1972. It weighed 6.9 g, the testes measured 5 x 4 mm, and the bird was moderately fat. Several other species of migrating warblers were seen, but this was the only one of this species. While this is the first specimen from Utah, the species has been seen several times before. Two were observed at Salt Lake City on 14 October 1962 (National Audubon Society, 1963a:54); one at Green River, Emery County, Utah, on 30 May 1968 (National Audubon Society, 1968:561); and some at the Bear River Refuge, Box Elder County, on 26 September 1971, (National Audubon Society, 1972:98). The species therefore appears to be an uncommon migrant.

Rose-breasted Grosbeak

A fourth record specimen of *Pheucticus ludovicianus* for Utah was obtained by William Buntin, M.D., at the Terry Ranch, 2500 ft elevation, Beaver Dam Wash, five miles north of the Utah-Arizona border on 19 May 1972. It was a male with testes that measured 10 x 8 mm. It was the male of a pair. Records of the species in Utah have been slow in accumulating until recent years, but it now seems that the species is of casual occurrence in the state and may breed, at least upon occasion. The first record was an observation of the species at Kanab on 26 April 1935 (Behle, et al, 1958). A second record, not heretofore recorded, pertains to a juvenile with soft mandibles and conspicuous yellow gape trapped by Calvin D. Wilson of the Tracy Aviary at his home in South Salt Lake on 4 August 1955. It was kept in a cage of native birds at the aviary until it died on 12 December. It was not saved.

The first specimen from the state was obtained by Roland Wauer (Wauer and Carter, 1965:78) at the Springdale Ponds, Washington County, near the entrance to Zion National Park on 3 May 1965. It is in the collection at the park. Wauer also saw one at Kanab (oral report) on 7 June 1965. A second speciment from Utah now in the collection at the University of Utah was killed by flying into a window at the residence area of Arches National Park near Moab, Grand County, on 26 May 1965 (Behle, 1966:396). The third specimen from the state, also in the University of Utah collection, was found dead at Fish Springs National Wildlife Refuge on 2 June 1965 (ibid.). Two days later another was seen there but not taken.

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SMALL MAMMALS OF THE NATIONAL REACTOR TESTING STATION, IDAHO[1]

Dorald M. Allred[2]

Abstract.— During studies of ectoparasites in 12 plant communities in 1966 and 1967, five types of traps were used to capture 2,478 mammals of the following 11 species: *Dipodomys ordii*, *Eutamias minimus*, *Microtus montanus*, *Onychomys leucogaster*, *Perognathus parvus*, *Peromyscus maniculatus*, *Reithrodontomys megalotis*, *Sorex merriami*, *Spermophilus townsendii*, *Neotoma cinerea*, and *Thomomys talpoides*. The most abundant species was *D. ordii* and the least, *M. montanus*. Plant communities which contained the greatest number of species were the *Chrysothamnus-Artemisia* and *Chrysothamnus*-grass *Tetradymia*. Fewest species were found in the grass and *Juniperus* communities. Greatest populations were in the *Juniperus* and grass communities, and lowest populations in the *Artemisia-Chrysothamnus*, *Artemisia-Atriplex*, and *Chrysothamnus*-grass-*Tetradymia* associations.

Between June 1966 and September 1967, ectoparasites were collected from mammals at the National Reactor Testing Station by personnel of Brigham Young University. The ectoparasites taken in those studies were reported by Allred (1968a, 1968b, 1970, 1971). In his 1968 report, Allred described the physical and ecological characteristics of the station, specific techniques used, and location of the study sites.

The station, situated in southeastern Idaho approximately 30 miles west of Idaho Falls, is in the Snake River Section of the Columbia River Basin. The vegetation is typical of the cool, northern desert shrub biome and is characterized predominantly by sagebrush (*Artemisia*), rabbitbrush (*Chrysothamnus*), and grasses of several genera.

Five types of traps were utilized to collect the small mammals: (1) the YAW live-catch trap, 15 inches long by 4½ inches square and made of three-mesh galvanized hardware cloth with a galvanized sheet metal door and reinforcement bands; (2) a modified Hubbard trap, 8 inches long and 3 inches square and made of galvanized sheet metal; (3) the can pit trap, which consists of an outer galvanized metal case 7 inches in diameter and 14 inches long, with a stainless steel, flanged inner can of slightly smaller size; (4) the Museum Special break-back trap; and (5) the California gopher trap. YAW, Museum Special, and Hubbard traps were baited with rolled oats; other traps were not baited. The latter traps were arranged in a radiating pattern (refer to Allred, 1968), with each type of trap arranged in two lines, 10 stations in each line, each station 10 meters apart with two traps per station (except pit cans, which consisted of one line with one can per station). All traps were operated simultaneously for a three-night period once each month.

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This paper describes the ecological distribution and relative abundance of the 2,478 small mammals of 11 species trapped in 12 different plant communities (Tables 1-3).

Results

Dipodomys ordii was much more abundant in the juniper community where an understory of *Chrysothamnus* and *Eurotia* was present, and in the grass community than in other communities. In these two communities almost all other species of small mammals were present only in minimal numbers compared to other communities of the station where the species were found. Two species, *Eutamias minimus* and *Peromyscus maniculatus*, occurred in next to their lowest populations in the *Juniperus*–mixed-understory association. *D. ordii* was found in all 12 communities, but populations were lowest in the *Artemisia–Chrysothamnus*–grass association. These kangaroo rats were the next to most abundant mammal in five communities.

Eutamias minimus was most abundant in the *Chrysothamnus–Artemisia*–grass association but was not found where grasses were predominant. These chipmunks were present in all other communities, although their populations were lowest in the *Chenopodium–Eurotia*, *Chrysothamnus*–grass–forb, and *Juniperus*–mixed-understory associations. They were the third most abundant species in five of the communities.

Microtus montanus was found only in the *Chrysothamnus–Artemisia* and *Elymus*–forb associations, and only in small numbers.

Onychomys leucogaster was found most abundantly in the *Chrysothamnus–Artemisia* association; in small numbers in the grass, *Chenopodium–Eurotia*, and *Juniperus*–mixed-understory associations; but was absent in the *Elymus*–forb, *Juniperus* (no under-

TABLE 1. Vegetative composition and cover in 12 communities at the National Reactor Testing Station, Idaho.

	Study site and percentage[1] cover											
Plant taxon	1	2	3	4	5	6	7	8	9	10	11	12
Artemisia	24	50				20	30	30	1	68	5	13
Atriplex								26			2	
Chenopodium									40			
Chrysothamnus	38	15				30	41	5	1		30	15
Elymus			50									
Eurotia		10					9		35			15
Juniperus					40							30
Opuntia	6									7	5	1
Salsola							3		2			
Stipa				40								
Tetradymia	2					30					22	
Forbs, misc	10	7	34	5	1	5		1	1	5	5	6
Grasses, misc.	15	15	1			5	1			7	26	10
Shrubs, misc.				5								
Bare ground	5	3	15		59	10	16	38	20	13	5	10

[1]Nearest whole percent.

Table 2. Relative abundance index[1] of some small mammals in different plant communities at the National Reactor Testing Station, Idaho.

Species	Plant community[2]											
	1	2	3	4	5	6	7	8	9	10	11	12
Dipodomys ordii Ord's kangaroo rat	27.0	1.0	12.0	143.0	64.0	51.0	10.0	40.0	69.0	61.0	51.0	180.0
Eutamias minimus Least chipmunk	38.5	20.5	8.5	0	10.5	4.0	11.0	4.0	1.0	15.5	2.0	2.0
Microtus montanus Montane vole	1.3	0	1.0	0	0	0	0	0	0	0	0	0
Onychomys leucogaster Northern grasshopper mouse	21.0	12.0	0	1.0	0	0	9.0	0	1.0	11.0	9.0	1.0
Perognathus parvus Great Basin pocket mouse	29.7	22.3	13.0	1.0	5.3	3.0	22.0	14.7	4.0	18.3	1.3	0
Peromyscus maniculatus Deer mouse	9.5	6.7	36.2	1.0	5.6	11.3	11.8	13.2	6.5	5.4	5.2	2.5
Reithrodontomys megalotis Western harvest mouse	2.0	2.0	5.0	0	0	0	2.0	0	0	7.0	1.0	0
Sorex merriami Merriam's shrew	1.0	0	0	0	0	3.0	1.0	0	0	0	2.0	1.0
Spermophilus townsendii Townsend's ground squirrel	1.0	8.0	11.0	0	0	1.0	6.0	3.0	13.0	0	1.0	0
Average index	14.6	8.1	9.6	16.2	9.5	8.1	8.1	8.3	10.5	13.1	8.1	20.7

[1]With 1 as the minimum number, the higher the index the greater the population.
[2]Refer to Table 1 for the vegetative components of the communities.

TABLE 3. Sequence of occurrence based on relative abundance index[1] of some small mammals within the same plant community at the National Reactor Testing Station, Idaho.

Plant community[2] and animal species	Relative abundance index[1]
Artemisia (site 10)	
Peromyscus maniculatus	10.0
Dipodomys ordii	8.7
Perognathus parvus	7.9
Eutamias minimus	4.4
Onychomys leucogaster	1.6
Reithrodontomys megalotis	1.0
Artemisia–Atriplex (site 8)	
Peromyscus maniculatus	57.3
Perognathus parvus	14.5
Dipodomys ordii	13.3
Eutamias minimus	2.5
Spermophilus townsendii	1.0
*Artemisia–Chrysothamnus–*Grass (site 2)	
Peromyscus maniculatus	87.0
Perognathus parvus	67.0
Eutamias minimus	41.0
Onychomys leucogaster	12.0
Spermophilus townsendii	8.0
Reithrodontomys megalotis	2.0
Dipodomys ordii	1.0
Chenopodium–Eurotia (site 9)	
Peromyscus maniculatus	85.0
Dipodomys ordii	69.0
Spermophilus townsendii	13.0
Perognathus parvus	12.0
Eutamias minimus	2.0
Onychomys leucogaster	1.0
Chrysothamnus–Artemisia (site 7)	
Peromyscus maniculatus	153.0
Perognathus parvus	66.0
Eutamias minimus	22.0
Dipodomys ordii	10.0
Onychomys leucogaster	9.0
Spermophilus townsendii	6.0
Reithrodontomys megalotis	2.0
Sorex merriami	1.0
*Chrysothamnus–Artemisia–*Grass (site 1)	
Peromyscus maniculatus	123.0
Perognathus parvus	89.0
Eutamias minimus	77.0
Dipodomys ordii	27.0
Onychomys leucogaster	21.0
Microtus montanus	5.0
Reithrodontomys megalotis	2.0
Sorex merriami	1.0
Spermophilus townsendii	1.0
Chrysothamnus–Grass–*Tetradymia* (site 11)	
Peromyscus maniculatus	68.0
Dipodomys ordii	51.0
Onychomys leucogaster	9.0
Eutamias minimus	4.0
Perognathus parvus	4.0
Sorex merriami	2.0
Reithrodontomys megalotis	1.0
Spermophilus townsendii	1.0
Chrysothamnus–Tetradymia–Artemisia (site 6)	
Peromyscus maniculatus	147.0
Dipodomys ordii	51.0
Perognathus parvus	9.0
Eutamias minimus	8.0
Sorex merriami	3.0
Spermophilus townsendii	1.0
Elymus–Forbs (site 3)	
Peromyscus maniculatus	117.8
Perognathus parvus	9.8
Eutamias minimus	4.3
Dipodomys ordii	3.0
Spermophilus townsendii	2.8
Reithrodontomys megalotis	1.3
Microtus montanus	1.0
Juniperus (site 5)	
Peromyscus maniculatus	4.6
Dipodomys ordii	4.0
Eutamias minimus	1.3
Perognathus parvus	1.0
Juniperus–Chrysothamnus–Eurotia (site 12)	
Dipodomys ordii	180.0
Peromyscus maniculatus	32.0
Eutamias minimus	4.0
Onychomys leucogaster	1.0
Sorex merriami	1.0
Oryzopsis–Stipa (site 4)	
Dipodomys ordii	143.0
Peromyscus maniculatus	13.0
Perognathus parvus	3.0
Onychomys leucogaster	1.0

[1]With 1 as the minimum number, the higher the index the greater the population.
[2]The predominant plant in each community is listed first, but others listed are also relatively abundant.

story), *Chrysothamnus—Artemisia*, and *Artemisia—Atriplex* communities.

Perognathus parvus was present in all of the communities except the *Juniperus*–mixed-understory association. Its populations were highest in the *Chrysothamnus–Artemisia* and lowest in the

grass and *Chrysothamnus*–grass–*Tetradymia* associations. It was the second most abundant species in five communities.

Peromyscus maniculatus was present in all 12 communities. It was most abundant in the *Elymus*–forb association and least abundant in the grass community. It was the most abundant species in 10 of the communities and the second most abundant in two.

Reithrodontomys megalotis was most abundant in the *Artemisia* community but was not common in any of the six communities where it was found. It was not found in the grass, *Juniperus* (no understory), *Chrysothamnus–Tetradymia–Artemisia*, *Artemisia–Atriplex*, *Chenopodium–Eurotia*, and *Juniperus*–mixed-understory associations.

Sorex merriami was most abundant in the *Chrysothamnus–Artemisia–Tetradymia* association. Although not abundant in any of the communities, it was also present in the *Chrysothamnus–Artemisia*, *Chrysothamnus*–grass–*Tetradymia*, and *Juniperus*–mixed-understory associations.

Spermophilus townsendii was most abundant in the *Chenopodium–Eurotia* association. It was not found in the grass, *Juniperus* (no understory), *Artemisia*, and *Juniperus*–mixed-understory associations. Its lowest numbers occurred in the *Chrysothamnus–Artemisia* and *Chrysothamnus*–grass–*Tetradymia* communities. It was the least abundant mammal in four of the communities in which it was found.

Neotoma cinerea, the bushy-tailed wood rat, was collected once in the *Juniperus* (no understory) community, but in all other collections it was taken near or in volcanic caves and outcroppings.

Thomomys talpoides, the northern pocket gopher, was found infrequently in the *Chrysothamnus–Artemisia*, *Artemisia–Chrysothamnus*, *Chenopodium–Eurotia*, and *Juniperus*–mixed-understory associations.

The communities that contained the greatest number of species were the *Chrysothamnus–Artemisia* and *Chrysothamnus*–grass–*Tetradymia*. Fewest species were found in the grass and *Juniperus* (no understory) communities.

Greatest populations of small mammals were found in the *Juniperus*–mixed-understory and grass communities, and fewest mammals in the *Artemisia–Chrysothamnus*, *Chrysothamnus–Artemisia*, *Artemisia–Atriplex*, and *Chrysothamnus*–grass–*Tetradymia* associations.

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SCORPIONS OF THE NATIONAL REACTOR TESTING STATION, IDAHO[1]

Dorald M. Allred[2]

ABSTRACT.— During ecological studies in 1966 and 1967, 282 scorpions of *Paruroctonus boreus* (Girard) were collected in can pit-traps in 12 plant communities. The ideal habitat was in vegetated areas where the total ground cover was more than 85 percent, of which at least 60 percent was broad-leaf shrubs and 5 percent grasses. Populations of ants and spiders were highest where scorpions were most abundant. Scorpions were most active above ground during August, with about half as much activity during July. None were found prior to May or after September.

Ecological investigations of ectoparasites and other arthropods of the National Reactor Testing Station were conducted by personnel of Brigham Young University from June 1966 to September 1967. Can pit traps that were used to trap ground-dwelling animals captured 282 scorpions of the species *Paruroctonus boreus* (Girard) in 12 plant communities. Some ecological data on these arachnids are reported herein. I am grateful to John Johnson for the identification of most of the specimens.

The National Reactor Testing Station, situated in southeastern Idaho approximately 30 miles west of Idaho Falls, is in the Snake River section of the Columbia River Basin. The vegetation is typical of the cool, northern desert shrub biome and is characterized predominantly by sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus*), and grasses of the genera *Agropyron*, *Elymus*, *Oryzopsis*, and *Stipa*. Allred (1968) described the ecological aspects of the station and defined and pictured the 12 study sites included here. The vegetative cover of each of these study sites is summarized below. For further details on the vegetation of the station, consult Atwood (1970).

Site 1: Chrysothamnus 38%, *Artemisia* 24%, grasses 15%, forbs 10.5%, *Opuntia* 6%, *Tetradymia* 1.5%, bare ground 5%.

Site 2: Artemisia 50%, *Chrysothamnus* 15%, grasses 15%, *Eurotia* 10%, forbs 7%, bare ground 3%.

Site 3: Elymus 50%, forbs 35%, bare ground 15%.

Site 4: Oryzopsis and *Stipa* 90%, shrubs 5%, forbs 5%.

Site 5: Juniperus 40%, forbs 1%, bare ground 59%.

Site 6: Chrysothamnus 30%, *Tetradymia* 30%, *Artemisia* 20%, grasses 5%, forbs 5%, bare ground 10%.

Site 7: Chrysothamnus 41%, *Artemisia* 30%, *Eurotia* 9%, forbs and grasses 4%, bare ground 16%.

Site 8: Artemisia 30%, *Atriplex* 26%, *Chrysothamnus* 5%, forbs and grasses 1%, bare ground 38%.

Site 9: Chenopodium 40%, *Eurotia* 35%, *Artemisia* and *Chrysothamnus* 2%, *Salsola* 2%, forbs 1%, bare ground 20%.

Site 10: Artemisia 68%, *Opuntia* 7%, grasses 7%, forbs 5%, bare ground 13%.

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Site 11: Chrysothamnus 30%, grasses 26%, *Tetradymia* 22%, *Artemisia* 5%, *Opuntia* 5%, forbs, *Atriplex* 2%, bare ground 5%.

Site 12: Juniperus 30%, *Chrysothamnus* 15%, *Eurotia* 15%, *Artemisia* 13%, grasses 10%, forbs 6%, *Opuntia* 1%, bare ground 10%.

Ten can pit traps spaced at 15-meter intervals were placed in a row at each site. These were open continuously from April to November. Cans were visited each day of a three-day period approximately every two weeks to collect the trapped animals. These visits were correlated with the times that other traps which were designed to capture rodents were in operation on each study site.

Discussion

Species distribution.— The occurrence of *Paruroctonus boreus* at the station is not unusual. This "northern scorpion," as it was designated by Ewing (1928), occurs from the Mojave Desert of California and southwestern Nevada northward into the Great Basin of Nevada, Utah, and Idaho; in the Upper Colorado River Basin of Arizona, Colorado, and Utah; in the Snake River and Columbia River basins of Idaho, Oregon, and Washington; in the Missouri River Basin of Montana, and in the southern part of Canada (Gertsch and Soleglad, 1966). Although this was the only species found at this northern latitude, Gertsch and Allred (1965) indicated that *Hadrurus spadix* occurs in eastern Oregon in the Columbia River Basin. Williams (1970a) also noted the occurrence of *H. spadix* in southwestern Idaho. Johnson and Allred (1972) indicated that the ranges of *Anuroctonus phaeodactylus* and *Vaejovis confusus* extend into northern Utah, and Anderson (personal correspondence) stated that *A. phaeodactylus* occurs in Idaho. Apparently these three species do not occur at the station, although perhaps they occupy a much different habitat than typified by the twelve study sites investigated and consequently were not captured in these studies.

Habitat preference.— Williams (1970b) found that the relative abundance of scorpions was related to habitat type. He observed that *Vaejovis confusus*, for example, was predominant in nonrocky, fine-textured soils, whereas some other species occurred primarily in rocky habitats. Undoubtedly the presence and relative abundance of scorpions are determined by edaphic factors as well as the vegetative components with their associated arthropods which serve as available food. At the Nevada Test Site, Gertsch and Allred (1965) found scorpions of *Paruroctonus boreus* most abundant in the Pinyon-Juniper community. They were seldom found in other plant types typical of the Mojave Desert but did occur somewhat abundantly in the *Artemisia* community typical of the northern deserts.

At the National Reactor Testing Station, scorpions of *P. boreus* varied significantly in abundance among the different plant communities (Table 1). In four of the communities none were found, and in two other communities only one and four specimens were taken, respectively. The ideal habitat for this species at the station

is in those vegetated areas where the total ground cover is more than 85 percent, of which about 60 percent is broad-leaf shrubs, and where grasses constitute at least 5 percent. The presence of forbs apparently is not influential to a significant degree. In all areas where populations of scorpions were highest, the total ground cover was above 85 percent. However, one exception where no scorpions were found was Site 4, where the cover was 100 percent but where 90 percent of this was grass with no shrubs present. In these same high-population areas (except the 90 percent grass area mentioned), the coverage by broad-leaf shrubs was above 60 percent, with two exceptions: Site 8, with a 61 percent shrub coverage where no grass occurred; and Site 7, with a 71 percent shrub coverage where grass coverage was less than 2 percent.

With one exception, populations of ants and spiders were also highest at those sites where scorpions were most abundant (Allred, 1969; Allred and Cole, 1971). On sites 4, 5, 8, and 9, where scorpions were not found, spiders were essentially absent from sites 4, 5, and 9, and ants were absent from sites 5 and 9.

Sex ratios.— Gertsch and Allred (1965) used can pit traps almost exclusively to capture scorpions in Nevada. The sex ratio of males to females collected there was 6 to 1. Johnson and Allred (1972) used an ultraviolet light for most of their collections and found the male to female ratio to be 1 to 1.9. In this study in Idaho, which utilized pit traps exclusively, the ratio was 5.5 to 1. From these data I assume that the males wander much more extensively than do the females and consequently are more apt to fall into the pit cans. Johnson and Allred (1972) noted that the females of *Anuroctonus phaeodactylus* were seen only at the entrances to their burrows. This same phenomenon of limited movement by the females, at least for most periods of the year, may also be applicable to *Paruroctonus boreus* in Idaho.

Table 1. Seasonal occurrence and abundance of *Paruroctonus boreus* at 12 sites at the National Reactor Testing Station during 1966 and 1967.

	No. specimens					
Site	May*	Jun.	Jul.	Aug.	Sep.	Total
1	6	3	23	9	4	45
2			15	26		41
3	2				2	4
4						0
5						0
6		2	11	24	1	38
7				1		1
8						0
9						0
10	2	3	6	25		36
11		8	14	43	2	67
12		2	9	35	4	50
Total	10	18	78	163	13	282

*Numbers for May are doubled, inasmuch as traps for that month operated only during 1967.

Seasonal occurrence.— At the National Reactor Testing Station, cold temperatures prevail from October to April, and snow frequently lies on the ground for much of that period. Scorpions were most active above ground during August, with about half as much activity during July (Table 1). None were found prior to May or after September. Immatures were found all summer except in May, and females were found from May to September (Table 2).

Table 2. Total numbers of *Paruroctonus boreus* taken seasonally at the National Reactor Testing Station during 1966 and 1967.

Stage or sex	No. specimens					
	May*	Jun.	Jul.	Aug.	Sep.	Total
Immature	4		6	1	3	14
Male		9	61	150	4	224
Female	6	9	11	12	6	44

*Numbers for May are doubled, inasmuch as traps for that month operated only during 1967.

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DENSITY CHANGES AND HABITAT AFFINITIES OF RODENTS OF SHADSCALE AND SAGEBRUSH ASSOCIATIONS

Earl J. Larrison and Donald R. Johnson[1]

Abstract.— Rodent trapping was conducted in representative northern Great Basin habitat types for six consecutive years to determine the magnitude of density change, the specific habitat affinities, and the effects of habitat alteration on rodent density. Although species responded differently, total rodent density was greater in depleted shadscale and sagebrush communities than in comparable pristine sites. However, disturbed sites with nearly pure stands of weedy introduced annuals supported few rodents.

Several species exhibited abrupt and concurrent yearly changes in density. The factors causing these changes were not identified. Until this information is available, we can develop only crude models to predict the direction and magnitude of population change.

Population ecologists lack information regarding the magnitude of density changes in small mammal populations. Ideally, population studies should extend over a sufficient time span to determine not only a mean density but also provide some estimate of the expected deviations from that mean. We are not aware of such a study in the Intermountain West.

Ecologists have gained some understanding of the habitat affinities of the more common rodents. The deer mouse (*Peromyscus maniculatus*) is recognized as eurytopic, while other species are known to be restricted to a few habitat types. The presettlement habitat affinities of most western species may never be fully known because of land clearing, livestock grazing, and the establishment of weedy annuals which are maintained in nearly pure stands by periodic fires.

The senior author began studies of small mammal populations in southern Idaho in 1951 in an effort to (1) determine the species representation in specific habitat types, (2) measure the magnitude of rodent density changes, and (3) determine the effects of habitat alteration on both species composition and density.

The press of other work prevented regular yearly sampling; however, trapping data are available for six consecutive years (1955-60) for several common habitat types of the northern Great Basin. Most of the trapping was conducted near Malta, Cassia County, Idaho, with additional investigations in Owyhee, Elmore, and Weiser counties. Sites were usually trapped during the summer months, although seasonal trapping was conducted in the Raft River Valley in 1957.

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Methods

Transect lines of 50 Museum Special traps were set out at 10-foot intervals and baited with rolled oats. The lines were maintained three days and checked twice daily to rebait and recover the catch. Effort was made to trap in stands of homogeneous vegetation. The habitat types were identified by the dominant plant species present, including big sagebrush (*Artemisia tridentata*), shadscale (*Atriplex confertifolia*), wheatgrass (*Agropyron cristatum* and *Agropyron desertorum*), kochia (*Kochia americana*), greasewood (*Sarcobatus vermiculatus*), and halogeton (*Halogeton glomeratus*).

The number, sex, and age group of each capture was recorded. An index of density (N/100 trap days) was calculated. Trapping at most sites was made in replication and the results reported as means. We made no effort to convert indices of abundance to density estimates. However, density and the catch from index lines are closely correlated (Hansson, 1967; Petticrew and Sadlier, 1970). We believe that these data accurately reflect density changes in these populations.

Results

Deer mice were the most abundant and ubiquitous species trapped in the Raft River Valley, often comprising 60-80 percent of the catch (Table 1). Depletion of shadscale and sagebrush-grass communities favors its increase. Deer mice were about twice as numerous in depleted shadscale stands in the Raft River Valley as in those in better condition (Table 1). No truly pristine shadscale stands remain in the valley after a long history of heavy grazing (Tisdale and Zappetini, 1953) and insect defoliation (Mackie, 1958). As a consequence, deer mice remained the most numerous rodent trapped in depleted stands as well as in those in better condition. In the more pristine shadscale and winterfat (*Eurotia lanata*) communities near Mountain Home, Elmore County, the catch of chisel-toothed kangaroo rats (*Dipodomys microps*) and Great Basin pocket mice (*Perognathus parvus*) regularly exceeded that of deer mice.

Deer mice were 8-9 times more numerous outside a 40-acre exclosure established in big sagebrush near Burley, Cassia County (Table 2). The grass understory outside the exclosure consisted almost entirely of cheatgrass (*Bromus tectorum*), while that inside included perennial species such as *Agropyron trachycaulum*, *Stipa comata*, and *Sitanion hystrix*. The vegetation within the exclosure had been protected from livestock since 1930 (Piemeisel, 1945).

Deer mice were the most abundant rodent trapped in saltsage (*Atriplex nuttalli*), black sage (*Artemisia arbuscula*), and Utah juniper (*Juniperus utahensis*) in the Raft River Valley and in mountain mahogany (*Cercocarpus ledifolius*) and western juniper (*J. occidentalis*) communities in Owyhee County.

Least chipmunks (*Eutamias minimus*) were most common in depleted shadscale stands, where their numbers averaged about 10 times greater than in stands in better condition (Table 3). Although none

TABLE 1. Mean catch of deer mice (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			4.3(28)			4.4(37)	
1956	Jul-Aug	12.0(68)	4.7(31)	9.2(63)	11.7(53)		5.0(43)	17.7(74)
1957	Apr	22.0(82)	16.3(67)	17.3(75)	14.2(64)			21.8(75)
	Jun	15.1(54)	4.7(24)	20.3(65)	23.7(76)	10.0(49)		25.7(69)
	Aug	5.0(52)	4.3(32)	14.0(72)	18.1(81)	6.3(50)		12.7(76)
1958	Aug	18.0(79)	11.3(50)	20.0(64)	11.3(68)	9.3(70)		
1959	Jun-Jul.	1.3(36)	0	3.2(27)	2.7(67)	1.7(33)	2.7(32)	
1960	Jun	15.3(92)	13.0(70)	20.7(77)	7.3(79)	3.0(43)		
	Aug			13.0(67)				
1964	May	46.7(85)		18.0(71)	18.7(80)			
Mean ± SE		16.9±4.9	7.8±2.2	14.0±2.1	13.5±2.4	6.1±1.7	4.0	19.5

TABLE 2. Number of rodents caught within and outside an exclosure in big sagebrush near Burley, Idaho, 1957. *Significant difference (P<.05).

Species	Inside Replication 1	2	3	Total	Outside Replication 1	2	3	Total
Deer mouse	1	4	5	10	41	28	26	95*
Least chipmunk	0	0	0	0	4	3	4	11*
Harvest mouse	6	1	1	8	0	0	0	0*
Ord kangaroo rat	2	3	0	5	2	0	0	2
Great Basin pocket mouse	0	7	4	11	1	1	0	2*
Totals	9	15	10	34	48	32	30	110*

were caught inside the Piemeisel exclosure, 11 were trapped in the sagebrush-cheatgrass outside it (Table 2), further evidence that range depletion favors an increase in its density.

The yellow pine chipmunk (*Eutamias amoenus*), which occupies the higher parts of several ranges in the northern Great Basin (Raft River Mountains, Cache Peak-Mount Harrison, Jarbidge Mountains), is absent from the Silver City Mountains of Owyhee County, where it is replaced by *Eutamias minimus*. The occurrence of the least chipmunk in a subalpine fir (*Abies lasiocarpa*) community on Boulder Summit confirms its ability to successfully colonize a variety of habitats in the absence of a sciurid competitor.

Ord kangaroo rats (*Dipodomys ordi*) were most abundant in stands of kochia in the Raft River Valley (Table 4) and along roadsides where disturbed earth provided easy tunneling (Johnson 1961). It is more abundant on sandy than on gravel substrates (Fautin, 1946; Maxell and Brown, 1968). This species successfully colonizes wheatgrass seedings (Table 4). Road building has permitted its dispersal into broad stretches of shadscale formerly occupied exclusively by *Dipodomys microps*.

In the Raft River Valley, chisel-toothed kangaroo rats were 2-3 times more abundant in "healthy" shadscale than in depleted stands (Table 5). In the more pristine shadscale and winterfat communities near Mountain Home it was the most common, and sometimes the only, rodent trapped. Shadscale leaves comprise most of its diet (Johnson, 1961), and its distribution closely coincides with that of shadscale in the Intermountain West. Kenagy (1972) has found that the chisel-shaped lower incisors are used to strip away the hypersaline epidermis of shadscale leaves; hence, only the less saline mesophyll is ingested. This species was also common (6.7/100 trap days) in a hop sage (*Grayia spinosa*) community west of Malta.

Western harvest mice (*Reithrodontomys megalotis*) were most abundant in seeded stands of wheatgrass (Table 6) and in giant wild rye (*Elymus cinereus*) communities of the Raft River Valley. Further evidence of its affinity for denser grass habitats was manifest at the Piemeisel exclosure (Table 2) and in a Wyoming study (Maxell and Brown, 1968).

Great Basin pocket mice were most common in seeded stands of wheatgrass and in big sagebrush-Idaho fescue (*Festuca idahoensis*)-bluebunch wheatgrass (*Agropyron spicatum*) communities. Its numbers are reduced in sage-grass habitat types sustaining heavy grazing (Table 2). This species was common (to 7.4/100 trap days) in a black sage community south of Albion, Cassia County. Although often considered a semi-desert species, it was trapped on Boulder Summit, Owyhee County, in subalpine fir (2500 m) and in a subalpine meadow (2750 m) near Lake Cleveland, Cassia County.

Other rodents trapped in smaller numbers included the sagebrush vole (*Lagurus curtatus*), the little pocket mouse (*Perognathus longimembris*), and the desert woodrat (*Neotoma lepida*). The habitat affinities of these species and those previously discussed are summarized in Table 7. We also caught grasshopper mice (*Ony-*

TABLE 3. Mean catch of least chipmunks (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			6.3(41)			4.0(33)	
1956	Jul-Aug	0.3(2)	0	1.5(10)	0.5(2)		1.0(9)	1.3(5)
1957	Apr	0.9(3)	0.3(1)	1.8(8)	0.2(1)			0.2(1)
	Jun	3.6(13)	0.7(3)	8.7(28)	2.3(7)	4.3(21)		4.0(11)
	Aug	0	0.3(2)	2.7(14)	0.3(1)	3.0(24)		0
1958	Aug	0	2.0(9)	6.0(19)	0	0		
1959	Jun-Jul	0.3(9)	0	6.2(51)	0	1.0(20)	2.3(28)	
1960	Jun	0.3(2)	0	4.0(15)	0	0.7(10)		
	Aug			6.0(31)				
1964	May	2.7(5)		3.0(12)	0			
Mean ± SE		1.0±0.5	0.5±0.3	4.6±0.7	0.4±0.3	1.8±0.8	2.4	1.4

TABLE 4. Mean catch of Ord kangaroo rats (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			0			0	
1956	Jul-Aug	2.0(11)	0	0	0.3(2)		1.0(9)	2.0(8)
1957	Apr	0	0.3(1)	0	2.4(11)			3.3(11)
	Jun	4.9(17)	1.0(5)	0.3(1)	3.0(10)	3.3(16)		1.7(4)
	Aug	1.3(14)	1.0(7)	0	0.7(3)	2.7(21)		0
1958	Aug	0.7(3)	0	0.7(2)	0	4.0(30)		
1959	Jun-Jul	1.7(45)	0	0.2(2)	0.3(8)	1.7(33)	1.7(20)	
1960	Jun	1.0(6)	0	0.7(2)	1.0(11)	3.3(48)		
	Aug			0				
1964	May	4.0(7)		0.3(1)	1.3(6)			
Mean ± SE		2.0±0.6	0.3±0.2	0.2±0.1	1.1±0.4	3.0±0.4	0.9	1.8

TABLE 5. Mean catch of chisel-toothed kangaroo rats (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			4.7(30)			3.1(26)	
1956	Jul-Aug	2.0(11)	9.7(64)	3.2(22)	0		3.7(31)	0
1957	Apr	2.2(8)	4.0(16)	2.2(10)	0			0.2(1)
	Jun	2.2(8)	8.7(45)	1.0(3)	0	2.0(10)		0
	Aug	2.3(24)	5.3(39)	2.3(12)	0	0.7(5)		0
1958	Aug	4.0(18)	8.7(38)	3.3(11)	0	0		
1959	Jun-Jul	0.3(9)	1.3(33)	1.6(13)	0	0.7(13)	1.3(16)	
1960	Jun	0	2.7(14)	0.3(1)	0	0		
	Aug			0.3(2)				
1964	May	1.3(2)		4.0(16)	0			
Mean ± SE		1.8±0.4	5.8±1.2	2.3±0.5	0	0.7±0.4	2.7	0.05

TABLE 6. Mean catch of western harvest mice (N/100 trap days), Raft River Valley. Percent of total catch in parentheses.

Year	Month	Big Sagebrush	Shadscale Healthy	Shadscale Depleted	Crested Wheatgrass	Kochia	Greasewood	Halogeton
1955	Jul			0			0	
1956	Jul-Aug	0.3(2)	0	0.3(2)	8.7(40)		0	1.3(5)
1957	Apr	0.9(3)	1.0(3)	0	4.2(19)			3.6(12)
	Jun	0.4(2)	1.7(9)	0	0.7(2)	0.3(2)		5.3(16)
	Aug	0.3(3)	1.0(7)	0	3.0(13)	0		2.3(14)
1958	Aug	0	0	0	5.3(32)	0		
1959	Jun-Jul	0	0	0	0.7(17)	0	0	
1960	Jun	0	0	0	0	0		
	Aug			0				
1964	May	0		0	0			
Mean ± SE		0.2±0.1	0.5±0.3	0.03	2.8±1.1	0.06	0	3.1

TABLE 7. Relative abundance of rodents in southern Idaho habitat types. ‡ = abundant (often > 10/100 trap days); § = common (often > 5/100 trap days); * = present, caught in small numbers; † = rare or absent. Scientific names abbreviated.

Habitat Type	P.m.	E.m.	D.o.	D.m.	R.m.	P.p.	L.c.	P.l.	N.l.
Greasewood	§	*	*	*	*	†	†	†	*
Salt sage	§	*	*	*	†	*	†	†	†
Healthy shadscale	§	*	*	§	*	*	†	*	*
Depleted shadscale	‡	§	*	*	*	†	†	*	†
Hopsage	§	*	*	§	*	†	†	†	*
Winterfat	*	*	†	§	†	*	†	†	†
Kochia	§	*	*	*	*	*	†	†	†
Halogeton	§	*	*	*	*	*	†	†	†
Sagebrush-cheatgrass	‡	*	*	*	*	*	*	*	*
Sagebrush-perennial grass	§	*	†	†	*	§	*	†	†
Crested wheatgrass	§	*	*	†	§	§	*	*	†
Black sage	§	*	†	*	*	*	†	†	*
Mountain mahogany	§	*	†	†	†	*	†	†	†
Juniper-big sage	§	*	†	†	†	*	†	†	*

chomys leucogaster) in almost all habitat types sampled, but its catch is not reported here because of the likelihood that it shuns rolled oats as bait. Small numbers of montane (*Microtus montanus*) and long-tailed voles (*M. longicaudus*) were also taken in grassy habitats throughout southern Idaho. Townsend ground squirrels (*Citellus townsendi*) were trapped in shadscale and winterfat communities. A few antelope ground squirrels (*Citellus leucurus*) were taken near the Bruneau Sand Dunes, Owyhee County.

Halogeton, an introduced annual chenopod, has invaded large areas of depleted shadscale in southern Idaho (Tisdale and Zappetini, 1953). Dense stands of halogeton sometimes support large numbers of deer mice (to 26/100 trap days) and a few of the other common species.

Former sage-grass habitat types which support weedy annuals contain few rodents. Heavy grazing and repeated fires have fostered the establishment of nearly pure stands of cheatgrass over vast areas of southern Idaho (Stewart and Hull, 1949). Such sites support only a few deer mice and Great Basin pocket mice. Medusahead (*Elymus caput-medusae*), a more recent invader, has replaced cheatgrass over nearly three-quarter of a million acres in southern Idaho (Hironaka, 1961). Nearly pure stands of this annual support even fewer rodents: only 8 deer mice were trapped in 900 trap days east of Weiser, Washington County. Former sagebrush-grass sites near Mountain Home supporting Russian thistle (*Salsola kali*) contained few rodents, but we caught considerable numbers (12.7/100 trap days) of western harvest mice in a stand of Russian thistle near Bridge, Cassia County. Former sagebrush-grass sites

supporting stands of tansy mustard (*Descurainia pinnata*) or pepper-grass (*Lepidium perfoliatum*) contain few rodents.

Much of this sagebrush range can be rehabilitated through reseeding with drought-resistant wheatgrasses. Although certain grass-adapted species are more numerous in wheatgrass seedings, the total rodent catch remains about the same as that on depleted sagebrush sites.

Discussion

The effects of grazing on rodent abundance has received considerable attention over the past half-century (reviews by Bond, 1945; Howard, 1953). Most of these studies have been conducted in central California, the Southwest, or on the Great Plains. Our data corroborate earlier findings that range depletion favors an increase in deer mice populations (Phillips, 1936; Quast, 1948) and tends to diminish the numbers of western harvest mice (Quast, 1948). We found that Great Basin pocket mice, like two other kinds of pocket mice in Arizona (Reynolds and Haskell, 1949), were most abundant in vigorous stands of perennial grasses. Like them, its numbers were reduced on depleted ranges.

There are interspecific differences in the responses of kangaroo rat populations to range depletion. While several species are more abundant on grazed sites (McCulloch, 1962; Reynolds, 1958; Quast, 1948), the numbers of chisel-toothed kangaroo rats are reduced in depleted shadscale stands (Table 5). Thus it is sometimes hazardous to generalize, predicting the response of a rodent population to habitat alteration, basing the prediction on the response expected from a related species.

In an earlier investigation, Fautin (1946:279) found that deer mice occurred in relatively low numbers in six communities within the shadscale and sagebrush associations of west central Utah. We found deer mice the most abundant rodent in all communities in the Raft River Valley, probably a result of its long history of heavy use by livestock. Although we found least chipmunks in all the habitat types trapped in the valley, Fautin found them restricted to sagebrush sites in Utah. Again, we ascribe this difference to the range depletion at our trapping sites.

The highest rodent numbers encountered in this study (46.7/100 trap days) were those of deer mice in a big sagebrush community in the Raft River Valley in May 1964 (Table 1). This level is greatly exceeded by microtine populations during irruptions (Piper, 1909; Federal Cooperative Extension Service, n.d.). As hunters, insectivorous and granivorous species such as the deer mouse search greater distances for food (McNab, 1963), and it is unlikely that they cannot achieve the high densities found in some foliage herbivore populations.

Rodent populations often exhibit abrupt changes in density (Horn and Fitch, 1942; Reynolds, 1958). We found that deer mice populations regularly changed by factors of 2 or 3 and sometimes

by a factor of 10 from one year to the next (Table 1). The catch of deer mice was 18/100 trap days in big sagebrush near Malta in 1958. It fell to 1.3/100 trap days in 1959 and then increased to 15.3/100 trap days the following year. Similar changes occurred in populations at other trapping sites during the same time interval (Table 1). These concurrent changes in populations of different species are in contrast to the independent changes occurring in rodent populations on desert grasslands in New Mexico (Wood, 1965, 1969).

In the Raft River Valley where trapping was conducted on a bimonthly basis during the 1957 field season, peak densities occurred in June for most species. The proportion of juvenile mice in the catch declined steadily, indicating that breeding terminated in late spring. Rodent populations reached low levels at these sites the following year.

Our understanding of the dynamics of small mammal populations will reach maturity only after we are able to identify those variables which most affect density. We can then develop sensitive models to predict population change, one of the goals of the International Biological Program, Biome Studies.

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NEW SPECIES OF AMERICAN *MICROCORTHYLUS* (COLEOPTERA: SCOLYTIDAE)[1]

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Abstract.— Species described include: *Microcorthylus demissus* and *M. invalidus* n. spp. (Mexico); *M. debilis* and *M. vescus* n. spp. (Guatemala); *M. pusillus* n. spp. (Guatemala and Honduras); *M. concisus* and *M. ocularis* n. spp. (Costa Rica); *M. inermis, M. lassus*, and *M. pumilus* n. spp. (Costa Rica and Panama); *M. dilutus* n. spp. (Colombia); *M. contractus, M. curtus, M. diversus, M. hostilis, M. umbratus* n. spp. (Venezuela).

While treating the genus *Microcorthylus* for my monograph of North and Central American Scolytidae, I encountered several undescribed species. In order to make names available for identification and other work, I have described 16 of those species below. Keys and other aids to identification will be included in the monograph. The species were taken in the following countries: Mexico (2), Guatemala (2), Costa Rica (2), Colombia (1), Venezuela (5), Guatemala and Honduras (1), Costa Rica and Panama (3).

Microcorthylus debilis, n. spp.

In this species the frontal punctures are rather coarse and elongate and the elytral declivity is only moderately impressed and devoid of an elevation between the costal margin and the lateral margin.

Female.— Length 1.8 mm (paratypes 1.6-1.9 mm), 2.8 times as long as wide; color yellowish brown.

Frons convex, with a distinct transverse impression just above epistoma, a weak, median epistomal process indicated; surface obscurely reticulate in central area, becoming almost rugose-reticulate in marginal areas; punctures coarse for this genus, elongate; subglabrous. Antennal club 1.1 times as long as scape, 1.4 times as long as wide, broadly somewhat obovate; sutures 1 and 2 almost straight; posterior face with small tuft of hair.

Pronotum 1.1 times as long as wide; widest near base, sides parallel on basal half, broadly rounded in front; about a dozen weakly raised serrations on anterior margin; indefinite summit just anterior to middle; anterior slope moderately steep, rather finely asperate; posterior areas strongly reticulate, sparse, very minute, shallow punctures indicated. Glabrous.

Elytra 1.6 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal two-thirds, then arcuately converging to lateral margin of declivity, broadly rounded behind on median half; strial punctures very obscurely indicated, interstrial punctures obsolete, discal surface subreticulate, subshining. Declivity steep, broadly sulcate; impressed area extending from suture to

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about striae 1 above and to striae 3 or 4 below; sutural interstriae feebly, abruptly elevated, forming a distinct, continuous crest on its lateral margin on right elytron; lateral margins increase in height gradually on upper two-thirds, obsolete below, crest of upper half armed by two pairs of rather widely separated, small, pointed denticles; all punctures obsolete; surface reticulate. Glabrous.

Male.— Similar to female except epistomal process forming a definite median tubercle; serrations on anterior margin of pronotum larger.

Type Locality.— Volcan Pacaya, Esquintla, Guatemala.

Type Material.— The male holotype, female allotype, and 28 paratypes were taken at the type locality on 1-VI-64, 4000 ft (1300 m), No. 670, from a broken branch 3 cm in diameter by S. L. Wood; other paratypes bear similar data except 2 are No. 669, and 5 are 653 from a woody vine; 23 paratypes are from Volcan Zunil, Quezaltenango, Guatemala, 27-V-64, 3000 ft (1000 m), No. 625, shrub, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus demissus n. sp.

This species is distinguished from *debilis* Wood by the smaller size, by the more shining, less strongly punctured female frons, male frons finely reticulate, and by the less strongly impressed elytral declivity.

Female.— Length 1.5 mm (paratypes 1.3-1.5 mm), 2.9 times as long as wide; color yellowish brown.

Frons as in *debilis* except central half smooth, shining, punctures not elongate; antennal club 1.3 times as long as scape, 1.5 times as long as wide.

Pronotum as in *debilis* except anterior margin more narrowly rounded.

Elytra as in *debilis* except declivity less strongly impressed, lateral margins much less strongly elevated.

Male.— Similar to female except frons uniformly, finely reticulate; anterior margin of pronotum armed by six rather coarse serrations; declivital denticles slightly larger.

Type Locality.— Six miles (9 km) NE Teziutlan, Puebla, Mexico.

Type Material.— The female holotype, male allotype, and 22 paratypes were taken at the type locality on 2-VII-67, 4800 ft (1500 m), No. 137, *Miconia*, S. L. Wood; other paratypes taken at the same locality by me include 11, No. 149, tree branch and 19 taken 27-VI-53, tree branch.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus ocularis, n. sp.

This species is distinguished from *demissus* Wood by the absence of a median epistomal tubercle, by the narrow frons, by the

enlarged, coarsely faceted eyes, and by the slender body form. Very similar to *dilutus* Wood.

Female.— Length 1.4 mm (paratypes 1.3-1.4 mm), 3.0 times as long as wide; color yellowish brown.

Frons as in *demissus* except mostly reticulate and epistomal tubercle reduced or absent. Eye greatly enlarged, coarsely faceted, frons correspondingly narrower as in *dilitus.* Pronotum and elytra more strongly reticulate.

Type Locality.— Tapanti, Cartago, Costa Rica.

Type Material.— The female holotype and two female paratypes were taken at the type locality in 2-VII-63, 4000 ft (1300 m), No. 10, in *Conostegia oerstediana*, by S. L. Wood. Four female paratypes bear identical data except No. 7B, in *Boehmeria ulmifolia;* one paratype is from 9 miles (15 km) SE Cartago, Cartago, Costa Rica, 24-XI-63, 5600 ft (1800 m), No. 24B *Siparuna nicaraguensis*, S. L. Wood.

The holotype and paratypes are in my collection.

Microcorthylus inermis, n. sp.

This species is distinguished from *demissus* Wood by the more strongly impressed elytral declivity, with the lateral margins abruptly but not strongly elevated, by the uniformly, finely, rugose-reticulate frons, and by the broader antennal club.

Female.— Length 1.5 mm (paratypes 1.5-1.6 mm), 2.8 times as long as wide; color dark brown.

Frons broadly convex, a conspicuous median tubercle just above epistomal process; entire surface from epistoma to vertex rugose-reticulate, minute punctures almost obsolete. Antennal club 1.3 times as long as scape, 1.3 times as long as wide; broadly obovate; a small tuft of setae on posterior face.

Pronotum 1.1 times as long as wide; as in *debilis* except posterior areas much more strongly reticulate.

Elytra 1.8 times as long as wide; as in *debilis* except entire surface uniformly reticulate; declivity more strongly impressed, lateral margins abruptly elevated.

Male.— Similar to female except frontal punctures more distinct; antennal club slightly smaller and devoid of tuft of hair on posterior face; serrations on anterior margin of pronotum rather coarse.

Type Locality.— Nine miles (15 km) SE Cartago, Cartago, Costa Rica.

Type Material.— The female holotype and 14 paratypes were taken at the type locality on 24-IX-63, 1800 m, No. 199, *Siparuna nicaraguensis*, by S. L. Wood; the male allotype and eight paratypes bear identical data except they are No. 248. Thirteen paratypes are from Escasu, San José, Costa Rica, 2-X-63, 1300 m, either No. 215 in *Guazuma ulmifolia* or No. 218 in a cut tree seedling; and four

paratypes are from Cerro Punta (labeled Volcan Chiriqui), Chiriqui, Panama, 11-I-64, 1800 m, Nos. 381, 399, in woody vines; all by me.

The holotype, allotype, and paratypes are in my collection.

Microcarthylus invalidus, n. sp.

This species is distinguished from *demissus* Wood by the more nearly reticulate frons, by the much more deeply impressed elytral declivity with its margins more abruptly elevated, and by the reticulate female scutellum.

Female.— Length 1.6 mm (paratypes 1.5-1.6 mm), 2.8 times as long as wide; color light brown.

Frons as in *demissus* except reticulation more intensive in lateral areas. Antennal club 1.2 times as long as wide.

Pronotum 1.2 times as long as wide; as in *demissus*.

Elytra as in *demissus* except declivity much more strongly impressed; declivity about as in *inermis* Wood except lateral margins of impressed area converge toward base at an angle of about 30 degrees (about 45 degrees in *inermis*).

Male.— Similar to female except frons rugose-reticulate, punctures minute; antennal club smaller, without tuft of hair on posterior face; anterior margin rather coarsely serrate.

Type Locality.— Four miles (6 km) W Tepic, Nayarit, Mexico.

Type Material.— The female holotype and male allotype were taken at the type locality on 13-VIII-65, 1000 m, No. 239, from a cut branch, by S. L. Wood. Two paratypes bear identical data except they are No. 240.

Microcorthylus pumilus, n. sp.

This species differs from all of the preceding forms in having a continuous, submarginal, subacute line extending from the suture to the costal margin to the lateral margin of the declivity; it is also unique in having the female frons very broad, with the mandibles proportionately lengthened.

Female.— Length 1.8 mm (1.7-1.9 mm), 2.9 times as long as wide; color very dark brown.

Frons very broad, particularly below, broadly convex; surface very finely punctured, finely rugose-reticulate to upper level of eyes, smooth and shining above. Antennal club 1.1 times as long as scape, 1.3 times as long as wide; obovate, widest through suture 2; posterior face without a tuft of long hair.

Pronotum 1.2 times as long as wide; sides almost straight and parallel on basal half, very broadly rounded in front; anterior margin weakly serrate; summit indefinite, on anterior third; anterior third finely asperate; posterior areas strongly reticulate, punctures minute, shallow. Glabrous.

Elytra 1.8 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on basal three-fourths, then arcu-

ately converging, almost straight behind on median two thirds; strial punctures obscurely indicated, almost obsolete; surface reticulate. Declivity very steep, almost vertical on lower half; rather narrowly sulcate on upper third, broadly impressed below; punctures obsolete, surface reticulate; suture narrowly elevated, lateral margin of this line subacuate, continued without interruption along costal submargin to lateral margin of declivity; impressed area somewhat heart-shaped; spines 1 and 2 almost obsolete. Glabrous except for a few hairlike setae near declivity.

Male.— Similar to female except lower frons normal, not as broad; antennal club more slender; anterior margin or pronotum more strongly serrate, 10 serrations.

Type Locality.— Nine miles (15 km) SE Cartago, Cartago, Costa Rica.

Type Material.— The female holotype, male allotype, and three paratypes were taken at the type locality in 3-VII-63, 1800 m, No. 17B, in cut *Conostegia oerstediana* branches, by S. L. Wood. One paratype is from Tapanti, Cartago, Costa Rica, 2-VII-63, 1300 m, No. 10, same host; and six paratypes are from Cerro Punta (labeled Volcan Chiriqui), Chiriqui, Panama, 11-I-64, 1800 m, No. 376, from a tree branch; all were taken by me.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus pusillus, n. sp.

This species is distinguished from *pumilis* Wood by the larger size, by the very different frons, by the tuft of hair on the posterior face of the female antenna, and by the larger declivital denticles.

Female.— Length 2.0 mm (paratypes 2.0-2.4 mm), 2.9 times as long as wide; color light reddish brown.

Frons with lateral thirds impressed from epistoma to slightly above eyes, median third strongly elevated, attaining a rather broad summit at a level slightly below upper level of eyes; surface reticulate in impressed areas, smooth and shining on median third and on entire area above eyes. Antennal club 1.2 times as long as wide; a small tuft of hair on posterior face.

Pronotum 1.02 times as long as wide; about as in *pumilus;* 14 serrations on an anterior margin. Glabrous.

Elytra about 1.6 times as long as wide, 1.7 times as long as pronotum; about as in *pumilus* except lower declivity narrower, and spines 1 and 2 small, but distinctly larger.

Male.— Similar to female except frons broadly, rather evenly convex; with a short median carina on lower fourth, central area very slightly elevated, surface reticulate and with moderately coarse, shallow punctures; serrations on anterior margin of pronotum slightly larger.

Type Locality. —Buenos Aires, Cortez, Honduras.

Type Material.— The female holotype, male allotype, and six

paratypes were taken at the type locality on 7-V-64, 2300 m, No. 576B, from a tree seedling, by S. L. Wood. Two paratypes are from Volcan Pacaya, Esquintla, Guatemala, 1-VI-64, 1300 m, No. 668, tree branch, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus lassus, n. sp.

This species is distinguished from all preceding species in this genus by the complete absence of an elevation or crest on declivital interstriae 1 and by the complete absence of sutures on the male antennal club, suture 1 and the ends of 2 occurring in the female.

Female.— Length 1.5 mm (paratypes 1.5-1.6 mm), 2.8 times as long as wide; color dark brown.

Frons as in *pumilus* Wood except mandibles normal. Antennal club 1.5 times as long as scape, 1.2 times as long as wide, suture 1 complete, 2 obsolete except at extreme margins.

Pronotum and elytral disc as in *pumilus*. Elytral declivity essentially as in *debilis* Wood except interstriae 1 not elevated, its lateral crest entirely obsolete; all punctures obsolete; surface reticulate.

Male.— Similar to female except sutures on antennal club obsolete (one specimen with suture 1 very feebly indicated); anterior margin of pronotum armed by two basally contiguous, coarse, pointed serrations.

Type Locality.— Tapanti, Cartago, Costa Rica.

Type Material.— The female holotype, male allotype, and two paratypes were taken at the type locality on 17-VIII-63, 1300 m, No. 106, from a woody vine, by S. L. Wood. Three paratypes are from Cerro Punta (labeled Volcan Chiriqui), Chiriqui, Panama, 11-I-64, 1800 m, No. 388, tree seedling, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus concisus, n. sp.

This species is distinguished from *grandiclavatus* Eggers by the smaller size, by the uniformly convex female frons, and by the less strongly impressed elytral declivity.

Female.— Length 1.8 mm (paratypes 1.6-1.8 mm), 2.6 times as long as wide; color dark brown.

Frons broadly convex, a slight transverse impression just above epistoma, a short, weak, median carina at epistomal margin; central area almost smooth, lower and lateral areas rugose-reticulate, punctures fine in smooth area, slightly coarser elsewhere. Antenna about as in *M. grandiclavatus*.

Pronotum and elytra as in *grandiclavatus* except declivity less strongly impressed; punctures and tubercles on declivital striae 1 smaller, varying in number from zero to four.

Male.— Similar to female except frons uniformly rugose-reticulate; anterior margin of pronotum serrate, one or two median pairs

larger; elytra obscurely to weakly reticulate; tubercles on declivital striae 1 larger, strial punctures almost or entirely obsolete.

Type Locality.— Volcan, Puntarenas, Costa Rica.

Type Material.— The female holotype, male allotype, and eight paratypes were taken at the type locality on 11-XII-63, 1000 m, No. 304, from a tree branch, by S. L. Wood. Seven paratypes are from San Ignacio de Acosta, San José, Costa Rica, 5-VII-63, 1500 m, No. 34, *Croton gossypiifolius*, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus vescus, n. sp.

This species is distinguished from *concisus* Wood by the larger size, by the absence of a median epistomal carina, by the more nearly strigose punctures on the frons, and by the strongly reticulate male elytra.

Female.— Length 2.1 mm (paratypes 2.0-2.3 mm), 2.5 times as long as wide; color brown.

Frons as in *concisus* except epistomal tubercle not at all carinate; punctures and impressed points slightly larger and more nearly longitudinally strigose.

Pronotum and elytra as in *concisus* except punctures on declivital striae 1 obsolete, accompanying tubercles minute.

Male.— Similar to female except frons more uniformly rugose-reticulate; anterior margin of pronotum serrate; elytral disc strongly reticulate to declivity (also in female); tubercles and punctures on declivital interstriae 1 larger, but smaller than in *grandiclavatus* Eggers.

Type Locality.— Volcan Zunil, Quezaltenango, Guatemala.

Type Material.— The female holotype, male allotype, and 24 paratypes were taken at the type locality on 27-V-64, 1000 m, No. 628, from a tree seedling, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus dilutus, n. sp.

This species is distinguished from *ocularis* Wood by the slightly larger size, by the stronger epistomal impression, with the lower frons flattened, and by the smoother elytra with the strial punctures in rows.

Male.— Length 1.6 mm (paralypes 1.5 mm), 2.8 times as long as wide; color yellowish brown (callow?).

Frons rather narrow, less than 1.2 times greatest width of eye; convex, somewhat flattened below, transversely impressed immediately above epistomal margin; surface almost smooth, with a few small, shallow punctures; vestiture very sparse, inconspicuous. Eye almost twice as large as in other species, very coarsely faceted. Antennal club large, 1.5 times as long as scape, 1.3 times as long as wide; sutures 1 and 2 almost straight.

Pronotum 1.1 times as long as wide; essentially as in *lassus* Wood except anterior margin very weakly serrate.

Elytra 1.9 times as long as wide, 1.8 times as long as pronotum; sides almost straight and parallel on basal three-fourths, very broadly rounded behind; disc almost smooth, subshining, strial punctures rather obscurely indicated, in rows. Declivity steep, shallowly sulcate, contours about as in *demissus* Wood; sutural interstriae weakly elevated, its lateral margin abrupt; surface reticulate.

Female.— Similar to male in all respects.

Type Locality.— Piedras Blancas, 10 km E Medellin, Antioquia, Colombia.

Type Material.— The male holotype, female allotype, and one paratype were taken at the type locality on 15-VII-70, 2500 m, No. 658, from a species of Guttiferae, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus hostilis, n. sp.

This species is somewhat similar to *rufotestaceus* Schedl but is distinguished by the larger size, by having the anterior margin of the pronotum armed in both sexes, by the slightly different frons, and by the complete absence of two large pits in declivital striae 1 in the male.

Female.— Length 2.6 mm (paratypes 2.6-2.7 mm), 2.5 times as wide; color dark brown.

Frons convex, a weak transverse impression just above epistoma, a low, blunt, median epistomal tubercle almost attaining epistomal margin, tubercle larger and nearer margin than in *rufotestaceus;* surface uniformly rugose-reticulate on lower two-thirds of area below eyes, more nearly reticulate on sides above, central area almost smooth and shining to vertex, punctures small, shallow, not close. Posterior face of antennal club with several long setae not exceeding tip of club.

Pronotum and elytra as in *rufotestaceus* except anterior margin of pronotum armed by at least two rather coarse, median serrations; and declivital spines 1 and 2 almost obsolete, lower declivity with several very small, irregularly placed granules. Fine vestiture as in *rufotestaceus.*

Male.— Similar in all respects to female except antennal club without long setae on posterior face.

Type Locality.— Thirty km N Merida, Merida, Venezuela.

Type Material.— The female holotype, male allotype, and 10 paratypes were taken at the type locality on 8-I-70, 2200 m, No. 226, from a broken branch, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus diversus, n. sp.

This species is distinguished from *hostilis* Wood by the slightly smaller size, by the idenfinite epistomal tubercle, by the differ-

ent frons, and by the row of punctures on declivital striae 1 of the male.

Male.— Length 2.3 mm (paratypes 2.2-2.4 mm), 2.5 times as long as wide; color dark brown.

Frons as in *hostilis* except epistomal tubercle essentially absent; rugose-reticulate area extending above eyes.

Pronotum and elytra as in *hostilis* except striae 1 on upper half of declivity with a series of seven (8 to 11 in paratypes) rather small, deep punctures; lower area of declivity more nearly reticulate and with fewer granules.

Female.— Similar to male except transverse impression above epistoma more distinct; frons from just below upper level of eyes to vertex smooth, brightly shining, with moderately abundant fine punctures and impressed points, antennal club with a few long hairs on posterior face; punctures on declivital striae 1 minute to obsolete.

Type Locality.— La Carbonera Experimental Forest, 50 km (airline) NW Merida, Merida, Venezuela.

Type Material.— The male holotype, female allotype, and 27 paratypes were taken at the type locality on 10-XI-69, 2500 m, Nos. 124, 126, 127 (type), from cut *Nectantra* seedlings, by S. L. Wood; 28 paratypes bear similar data except 27-X-69, No. 91A; 18 paratypes are from Colonia Tovar, Aragua, Venezuela, 4-V-70 1700 m, No. 485, *Nectandra*, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcoorthylus umbratus, n. sp.

This species is distinguished from *diversus* Wood by the smaller size, by the different frons in both sexes, by the much less strongly impressed elytral declivity, and by the much smaller punctures on the male striae 1.

Male.— Length 1.9 mm (paratypes 1.9-2.2 mm), 2.5 times as long as wide; color brown to very dark brown.

Frons as in *diversus* except strongly rugose-reticulate from epistoma to vertex; rather dull.

Pronotum and elytral disc as in *diversus* except anterior margin of pronotum with up to six serrations; elytral declivity much less strongly impressed, lateral convexities rather weakly elevated, dull, finely reticulate, striae 1 with about eight (7-11 in paratypes) minute punctures on middle half of declivity.

Female.— Similar to male except lower third of frons abruptly, rather shallowly impressed (stronger than in female *diversus*), upper area on median half smooth, brightly shining; posterior face of antennal club with several long hairs; anterior margin of pronotum feebly serrate; punctures on declivital striae 1 obsolete.

Type Locality.— La Carbonera Experimental Forest, 50 km (airline) NW Merida, Merida, Venezuela.

Type Material.— The male holotype, female allotype, and nine paratypes were taken at the type locality on 10-XI-69, 2500 m, Nos.

125, 126 (type), 127, from cut *Nectandra* seedlings, by S. L. Wood; 14 paratypes bear similar data except 27-X-69, 91A; 3 paratypes are from the Merida Teleferico, Merida, Venezuela, 27-II-70, 2500 m, No. 332, *Nectandra*, S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus curtus, n. sp.

This species differs from all of the preceding species in having the lateral margin of the declivity continued at the base to the suture, and in having the face of the declivity finely punctured, not reticulate.

Male.— Length 1.6 mm (paratypes 1.5-1.7 mm), 2.5 times as long as wide; color dark brown.

Frons evenly convex from epistoma to vertex; surface rugose-reticulate from epistoma to upper level of eyes, upper areas almost smooth, with numerous impressed points and a few rather fine, shallow punctures; vestiture inconspicuous. Antennal club 1.5 times as long as scape, 1.15 times as long as wide, subcircular; sutures 1 and 2 clearly indicated.

Pronotum and elytral disc essentially as in *diversus* Wood, except elytral disc on posterior third weakly reticulate with some small, smooth, shining areas. Elytral declivity subvertical, broadly impressed, not sulcate at base; lateral margins moderately, rather abruptly elevated on upper two-thirds, continued to suture, armed in usual position by minute spines 1 and 2; declivital face minutely, densely punctured. Vestiture confined to declivital face, of very short, fine, abundant hair.

Female.— Similar to male except anterior margin of pronotum unarmed.

Type Locality.— Twenty km SW El Vigía, Merida, Venezuela.

Type Material.— The male holotype, female allotype, and six paratypes were taken at the type locality on 10-XII-69, 50 m, No. 190, from a cut tree seedling, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Microcorthylus contractus, n. sp.

This species is distinguished from *curtus* Wood by the more extensively reticulate, subaciculate frons, by the more numerous serrations on the anterior margin of the pronotum, and by the less extensive, more shallowly impressed elytral declivity.

Male.— Length 1.4 mm (paratypes 1.4-1.6 mm), 2.5 times as long as wide; color brown.

Frons as in *curtus* except abundant impressed points longitudinally strigose.

Pronotum and elytra as in *curtus* except anterior margin of pronotum armed by about 14 serrations of about equal size; elytral declivity strongly reticulate to declivity. Elytral declivity trangular-

ly impressed on a limited area, lateral margins not strongly elevated, their upper limits attaining area of striae 1; striae 1 with a row of very small, obscure punctures on lower two-thirds; surface reticulate. Subglabrous.

Type Locality.— Seven km NW Socopo, Barinas, Venezuela.

Type Material.— The male holotype and four male paratypes were taken at the type locality on 13-II-70, 200 m, No. 332, from a cut *Nectandra* seedling, by S. L. Wood.

The holotype and paratypes are in my collection.

THE NOMINAL SNAKE GENERA *MASTIGODRYAS* AMARAL, 1934, AND *DRYADOPHIS* STUART, 1939

Hobart M. Smith[1] and Kenneth R. Larsen[1]

ABSTRACT.— Some recent workers who have combined the genera *Mastigodryas* Amaral, 1834, and *Dryadophis* Stuart, 1939, under the former name, have done so prematurely in view of characters by Amaral that differentiate them. Either the genera should be maintained distinct, or the younger, but widely-known name, *Dryadophis*, should be retained through exercise of the plenary powers of the ICZN, already requested.

Prompted by Romer's (1956: 577) indication of the synonymy of *Mastigodryas* Amaral, 1934, and *Dryadophis* Stuart, 1939, a proposal was made (Smith, 1963) that *Mastigodryas* be suppressed under the plenary powers of the International Commission on Zoological Nomenclature in order to preserve the more familiar *Dryadophis*. The ICZN never acted upon the proposal, however, because Amaral (1964) pointed out that the monotypic *Mastigodryas* should not be regarded as a synonym of *Dryadophis*, since it has no apical scale pits and 70 subcaudals, whereas in *Dryadophis* the subcaudals number 79 or more, and paired apical scale pits are present in all species.

Nevertheless Peters and Orejas-Miranda (1970:190) lumped the two genera, citing all valid Central and South American species-group taxa of *Dryadophis* under the generic name *Mastigodryas*. No mention was made of the comments by Smith and Amaral that appeared in the *Bulletin of Zoological Nomenclature*; but Romer's observation was noted and the comment added that Peters had seen the type of *M. danieli*, that he concluded it is congeneric with *Dryadophis*, and that priority should be observed.

We have not seen any specimens of *M. danieli*, but on the basis of Amaral's (1964) comments maintain that to regard it as congeneric with *Dryadophis* is premature. *Dryadophis* merits perpetuation until more conclusive evidence of synonymy with *Mastigodryas* is available. If such a conclusion is confirmed, reconsideration should be given to suppression of the nominal genus *Mastigodryas* in order to preserve the widely known name *Dryadophis*, resubmitting for ICZN action the proposal first presented in 1963.

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